

**UNITED STATES
SECURITIES AND EXCHANGE COMMISSION**
Washington, D.C. 20549
FORM 10-K

(Mark One)

ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the fiscal year ended December 31, 2022
or

ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the transition period from to
Commission File Number: 001-38295

X4 PHARMACEUTICALS, INC.

(Exact name of registrant as specified in its charter)

Delaware
(State or other jurisdiction of incorporation or organization)

27-3181608
(I.R.S. Employer Identification No.)

61 North Beacon Street, 4th Floor
Boston, Massachusetts
(Address of principal executive offices)

02134
(Zip Code)

(857) 529-8300
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class
Common Stock

Trading Symbol(s)
XFOR

Name of each exchange on which registered
The Nasdaq Stock Market LLC

Securities registered pursuant to Section 12(g) of the Act: none

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes No

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes No

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days Yes No

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes No

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large Accelerated Filer	<input type="checkbox"/>	Accelerated Filer	<input type="checkbox"/>
Non-accelerated filer	<input checked="" type="checkbox"/>	Smaller reporting company	<input checked="" type="checkbox"/>
		Emerging growth company	<input type="checkbox"/>

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.

Indicate by check mark whether the registrant has filed a report on an attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report. Yes No

If securities are registered pursuant to Section 12(b) of the Act, indicate by check mark whether the financial statements of the registrant included in the filing reflect the correction of an error to previously issued financial statements.

Indicate by check mark whether any of those error corrections are restatements that required a recovery analysis of incentive-based compensation received by any of the registrant's executive officers during the relevant recovery period pursuant to § 240.10D-1(b).

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act).

On June 30, 2022, the aggregate market value of the registrant's voting common stock held by non-affiliates of the registrant was approximately \$29.6 million based upon the closing sale price on the Nasdaq Capital Market reported on June 30, 2022.

Independent Registered Public Accounting Firm	PricewaterhouseCoopers LLP	Boston, Massachusetts, US	Firm ID	238
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As of March 15, 2023, there were 122,207,488 shares of the registrant's common stock, \$0.001 par value per share outstanding.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the registrant's definitive proxy statement, (the "2023 Proxy Statement") for its 2023 Annual Meeting of Stockholders, which the registrant intends to file pursuant to Regulation 14A with the Securities and Exchange Commission not later than 120 days after the registrant's fiscal year ended December 31, 2022, are incorporated by reference into Part III of this Annual Report on Form 10-K.

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CAUTIONARY NOTE REGARDING FORWARD-LOOKING STATEMENTS

This Annual Report contains forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended (the "Securities Act"), and Section 21E of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), that relate to future events or to our future operations or financial performance. These statements may be identified by such forward-looking terminology as "may," "should," "expects," "intends," "plans," "anticipates," "believes," "estimates," "predicts," "potential," "continue" or the negative of these terms or other comparable terminology. Our forward-looking statements are based on a series of expectations, assumptions, estimates and projections about our company, are not guarantees of future results or performance and involve substantial risks and uncertainty. We may not actually achieve the plans, intentions or expectations disclosed in these forward-looking statements. Actual results or events could differ materially from the plans, intentions and expectations disclosed in these forward-looking statements. These forward-looking statements are subject to a number of known and unknown risks, uncertainties and assumptions, including risks described in the section titled "Risk Factors" and elsewhere in this report, regarding, among other things:

- the initiation, timing, progress and results of our current and future preclinical studies and clinical trials and related preparatory work and the period during which the results of the trials will become available, as well as our research and development programs;
- the potential benefits, including clinical utility, that may be derived from any of our product candidates;
- the timing of and our ability to obtain and maintain regulatory approval of our existing product candidates or any product candidates that we may develop in the future, and any related restrictions, limitations, or warnings in the label of any approved product candidates;
- our plans to research, develop, manufacture and commercialize our product candidates;
- the timing of our regulatory filings for our product candidates, along with regulatory developments in the United States and other foreign countries;
- the size and growth potential of the markets for our product candidates, if approved, and the rate and degree of market acceptance of our product candidates, including reimbursement that may be received from payors;
- the benefits of U.S. Food and Drug Administration and European Commission designations, including, without limitation, Fast Track, Orphan Drug and Breakthrough Therapy;
- our commercialization, marketing and manufacturing capabilities and strategy;
- our ability to attract and retain qualified employees and key personnel;
- our competitive position and the development of and projections relating to our competitors or our industry;
- our expectations regarding our ability to obtain and maintain intellectual property protection;
- the success of competing therapies that are or may become available;
- our estimates and expectations regarding future operations, financial position, revenues, costs, expenses, uses of cash, capital requirements or our need for additional financing;
- our ability to continue as a going concern;
- our plans to in-license, acquire, develop and commercialize additional product candidates;
- the impact of laws and regulations;
- our plans to identify additional product candidates with significant commercial potential that are consistent with our commercial objectives;
- our ability to raise additional capital;
- our strategies, prospects, plans, expectations or objectives; and
- other risks and uncertainties, including those listed under the section titled "Risk Factors" in this Annual Report.

You should refer to the section titled “Risk Factors” in this Annual Report for a discussion of important factors that may cause our actual results to differ materially from those expressed or implied by our forward-looking statements. As a result of these factors, we cannot assure you that the forward-looking statements in this Annual Report will prove to be accurate. Furthermore, if our forward-looking statements prove to be inaccurate, the inaccuracy may be material. In light of the significant uncertainties in these forward-looking statements, you should not regard these statements as a representation or warranty by us or any other person that we will achieve our objectives and plans in any specified time frame, or at all. We undertake no obligation to publicly update any forward-looking statements, whether as a result of new information, future events or otherwise, except as required by law. You should, therefore, not rely on these forward-looking statements as representing our views as of any date subsequent to the date of this Annual Report.

Unless the context requires otherwise, references in this Annual Report to “X4”, “we”, “us” and “our” refer to X4 Pharmaceuticals, Inc. and its subsidiaries.

PART I

ITEM 1. BUSINESS

Overview

We are a late clinical-stage biopharmaceutical company discovering and developing novel therapeutics for the treatment of rare diseases and those with limited treatment options, with a focus on conditions resulting from dysfunction of the immune system.

Our lead clinical candidate is mavorixafor, a small molecule antagonist of chemokine receptor CXCR4, that is being developed as an oral, once-daily therapy. Due to its ability to increase the mobilization of mature, functional white blood cells from the bone marrow into the bloodstream, we believe that mavorixafor has the potential to provide therapeutic benefit across a variety of chronic neutropenic disorders, including WHIM (Warts, Hypogammaglobulinemia, Infections, and Myelokathexis) syndrome, a rare, primary immunodeficiency.

Following announcement of positive top-line data from our global, pivotal, Phase 3 clinical trial, we are currently preparing a United States regulatory submission seeking approval of oral, once-daily mavorixafor in the treatment of people aged 12 years and older with WHIM syndrome. We are also currently advancing mavorixafor in a Phase 2 clinical trial in people with certain chronic neutropenic disorders following positive results from a Phase 1b clinical trial of mavorixafor in people with idiopathic, cyclic or congenital neutropenia.

We believe that successfully developing mavorixafor and providing new therapeutic options to individuals in the United States diagnosed with certain chronic neutropenic disorders has the potential to revolutionize the treatment landscape, which is principally served by injectable therapies that are frequently associated with treatment-limiting adverse events.

Our Focus

We have developed a pipeline of small-molecule, oral antagonists of the chemokine receptor CXCR4. CXCR4, or C-X-C receptor type 4, is a cell receptor that helps regulate the movement of immune cells within the body. CXCR4 receptor stimulation by its cognate ligand, CXCL12, has been shown to play a key role in the maturation and mobilization of white blood cells such as neutrophils, lymphocytes (including both B cells and T cells), and monocytes, into the bloodstream. Because antagonism of the CXCR4 receptor has been shown to increase the trafficking of white blood cells, we believe that therapeutic inhibition of the CXCR4/CXCL12 axis holds the potential to benefit people with a wide variety of diseases where there remain significant unmet needs, including chronic neutropenic disorders and certain types of cancer.

Chronic neutropenic disorders are rare blood conditions where people of all ages experience low levels of neutrophils and tend to be at greater risk of developing infections and certain types of cancer. Depending on the levels of circulating neutrophils in the blood, neutropenia can be categorized as mild, moderate, or severe.

We are currently focused on advancing our lead clinical candidate, mavorixafor, for the treatment of a number of chronic neutropenia indications, including WHIM syndrome, while also pursuing partnership opportunities to further advance our previous work in oncology indications.

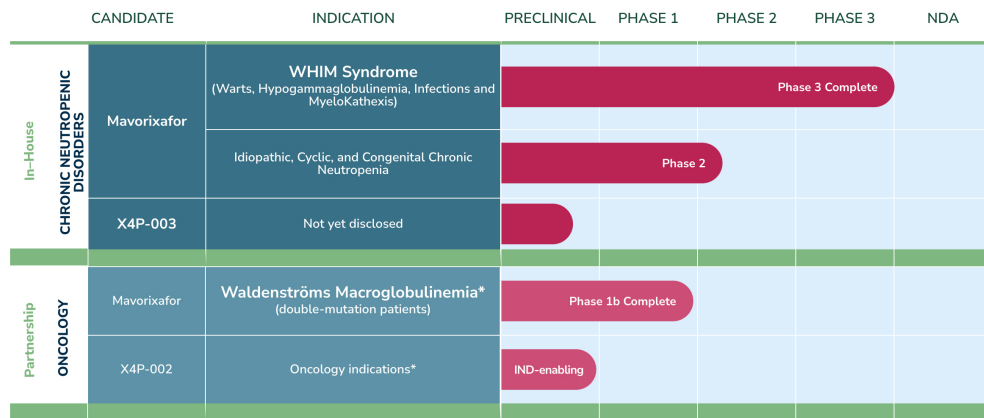
Our Pipeline

Our deep understanding of the biology of the CXCR4 pathway has enabled us to discover and develop multiple small-molecule CXCR4 antagonists. To date, we have advanced our lead candidate, mavorixafor, into late-stage clinical development. Mavorixafor is an orally available, small-molecule CXCR4 antagonist designed to facilitate the mobilization of white blood cells from the bone marrow into the blood, to increase levels of circulating neutrophils, lymphocytes, and monocytes, and to improve immune system function.

To date, more than 200 patients in clinical trials have been dosed with mavorixafor, which has demonstrated a favorable tolerability profile. In these trials, we have observed drug exposure in patients, a 22-hour half-life, and bioavailability of mavorixafor to support once-daily oral dosing, which we believe would provide convenient dosing and better patient compliance for chronic or life-long use, if approved. The manufacturing process for mavorixafor utilizes well established, small-molecule chemistry, creating the potential for a commercial product that can be supported by specialty pharmacy distribution.

We have successfully advanced mavorixafor through a pivotal, Phase 3 clinical trial, referred to as the 4WHIM trial, in people with WHIM (Warts, Hypogammaglobulinemia, Infections, and Myelokathexis) syndrome, a rare, primary immunodeficiency, through a Phase 1b clinical trial in people with congenital, idiopathic, or cyclic neutropenia, and through a Phase 1b clinical trial of mavorixafor in combination with the Bruton tyrosine kinase inhibitor ibrutinib in people with a rare B-cell lymphoma called Waldenström's macroglobulinemia ("Waldenström's").

We have also developed two pre-clinical candidates: X4P-003, a second-generation CXCR4 antagonist designed to have enhanced properties relative to mavorixafor, potentially enabling broader opportunities in CXCR4-dependent disorders and primary immunodeficiencies; and X4P-002, a CXCR4 antagonist with a unique distribution profile and a demonstrated ability to cross the blood-brain barrier.



* Programs only being advanced through partnership

Following our July 2022 announced strategic re-prioritization, we are now advancing mavorixafor solely in chronic neutropenic disorder indications, including WHIM syndrome, while pausing our pre-clinical programs and only progressing our oncology programs upon completion of strategic partnership(s).

About WHIM Syndrome

WHIM syndrome is both a rare combined immunodeficiency and a congenital neutropenic disorder in which the body’s immune system does not function properly and has trouble fighting infections. In many patients, WHIM is caused by “gain of function” variations in the single gene that encodes for the CXCR4 receptor. In healthy individuals, the CXCR4 receptor is typically internalized into the cell after CXCL12 binds to it, enabling the receptor to be appropriately “recycled” and the signaling to be diminished. In most WHIM patients, however, a genetic variation in the receptor gene prevents the post-binding internalization (“normal recycling”) of the receptor. As a result, the CXCR4 receptor is maintained on the surface of the cell and is exposed to the ligand, which creates a perpetual “on” signal and retention of white blood cells in the bone marrow where they are produced, leading to the chronic peripheral neutropenia, lymphopenia, and monocytopenia that are the clinical hallmarks of WHIM syndrome.

Genetic testing is typically used to diagnose WHIM syndrome to confirm the presence of a genetic variation in the CXCR4 receptor. The diagnosis of WHIM syndrome may occur at any age: about one-half of reported patients are diagnosed as children, primarily before or at the age of 18 years, with the other half diagnosed as adults, mostly between 18 and 40 years of age.

WHIM syndrome is named for its four common clinical findings, although not all patients experience all symptoms, and not all symptoms are required for a diagnosis: **W**arts, related to infection with the Human Papilloma Virus (HPV), **H**ypogammaglobulinemia, a condition of low immunoglobulin (“IG”) levels, **I**nfections, including both bacterial and fungal infections, and **M**yelokathexis, a hyper-dense population of immune cells in the bone marrow. These conditions reduce the body’s ability to achieve a healthy immune response. Approximately 30-40% of people with WHIM syndrome develop HPV-associated cancers as they age.

The incidence and prevalence of WHIM syndrome are not well established. We believe that this is due to the relatively recent elucidation of the genetics underlying WHIM syndrome, lack of universal or accessible genetic testing, and limited medical education and awareness of the disease, which is in part driven by the lack of available disease-modifying treatments. Based on a preliminary U.S market research study sponsored by us and conducted by a third-party research firm, we believe that the prevalence of WHIM syndrome worldwide is significantly higher than previous registries suggest.

- The study solicited input from community-based physicians of different specialties, including physicians focused on non-malignant hematology, immunology, dermatology, pulmonology, and infectious diseases, who are known to manage and/or treat patients with WHIM syndrome.
- The 212 physicians across these specialties identified to participate in this study reported more than 1,700 patients in the United States with genetically confirmed or highly probable WHIM syndrome.

In addition, we have also completed a study using artificial intelligence, interrogating a database of approximately 300 million American lives that included up to 10 years of insurance claims on diagnoses, drug treatments, procedures, and treatment pathways. This study suggests that there may be as many as 3,700 WHIM patients in the United States based on the WHIM-like phenotypes described.

The first CXCR4 genetic variation determined to cause WHIM syndrome was identified in 2003. Since then, several CXCR4 variations have been identified as “gain of function” variations causing WHIM syndrome. Our research has subsequently identified a number of new genetic variations, among them a new missense variation, called D84H, that is relatively frequent in the general population. The D84H mutation is the first mutation to be identified outside of the C-terminus of the CXCR4 receptor showing gain-of-function signaling and WHIM disease phenotype. We believe that the frequency of the D84H variation, as derived from broad population genomic databases, further supports our current WHIM prevalence estimate. Our research into additional WHIM-causing genetic variations is ongoing and we are continuing to identify novel pathogenic variants, further expanding our understanding of the clinical phenotype of people with WHIM syndrome.

In partnership with Invitae, a genetic information company, we sponsor a no-charge genetic testing and counseling program called PATH4WARD for individuals who may carry a genetic variation known to be associated with chronic neutropenia or primary immunodeficiency disorders (“PIDs”), including WHIM syndrome. The genetic panel looks at more than 550 genes known to be associated with PIDs; to date, the program has proven helpful not only in identifying WHIM patients, but also providing a better understanding of novel genetic variants causing PIDs and assisting participant enrollment in X4-sponsored clinical trials.

We plan to continue to increase awareness of WHIM syndrome among patients, physicians, and their support systems through our partnerships with key patient foundations and registries, including the Jeffrey Modell Foundation, University of Washington, Immune Deficiency Foundation, and Hopitaux Universitaires Est Parisien (Trousseau La Roche-Guyon).

We have also deployed a field force of Medical Science Liaisons (“MSLs”) and Patient Diagnostic Liaisons (“PDLs”) in the United States to further drive education and awareness of WHIM syndrome and to assist in identifying WHIM patients.

Limited Current Treatment Landscape for WHIM Syndrome

Currently, there are no approved therapies for the treatment of WHIM syndrome and care is limited to the treatment of the syndrome’s different symptoms, mainly the prevention and management of infections. None of these symptomatic treatments, however, address the underlying cause of this multi-faceted disease. Current symptoms and their treatment limitations are as follows:

- **Warts:** The presence of warts in WHIM syndrome is driven by an underlying HPV infection. Standard treatments, such as topical therapies (for example, imiquimod and salicylic acid), cryotherapy and laser therapy, as well as more aggressive approaches, such as cauterization or surgical removal, have been ineffective in providing durable treatment of warts associated with chronic HPV infections. As WHIM patients generally have limited response to vaccines, the HPV vaccine appears to have limited effectiveness. The number, size, and severity of visible warts in WHIM patients can have a significant negative impact on the patient’s quality of life and result in social anxiety issues. Left untreated, chronic HPV-infections are also known to increase the risk of cancer.
- **Hypogammaglobulinemia:** Intravenous or subcutaneous IG administration, referred to as IVIG or SCIG, respectively, can be administered to patients with low IG levels. In WHIM patients, the administration of IG therapies raises IG levels, but has shown no impact on circulating white blood cells and limited or no impact on immune responses. IG treatment of patients with WHIM syndrome is based on empirical and anecdotal evidence, and there are no clinical data demonstrating the efficacy of IG treatment for WHIM syndrome. IG treatment also does not treat or protect against HPV-associated symptoms and diseases, such as warts and certain cancers. Furthermore, IG administration is costly and time consuming.
- **Infections:** Bacterial infections are managed with antibiotics. Acute infections usually resolve, although we are aware of reports from clinicians citing death due to pneumonia or sepsis in young WHIM patients. Importantly, even with antibiotic use, infections are known to recur more frequently and persist longer in patients with WHIM syndrome. Further, the toll of multiple, chronic infections in WHIM patients has been known to lead to devastating irreversible pathologies such as hearing loss, due to chronic ear infections and bronchiectasis, or damaged lung airways. Patients are sometimes given granulocyte-colony stimulating factor (“G-CSF”) to increase neutrophil counts, but G-CSF has demonstrated little, if any, impact on lymphopenia or the incidence of infections in WHIM patients. Side effects of G-CSF have been reported to include disabling bone pain, which can be more severe in certain age groups. Additional, less common, treatment-limiting complications of chronic G-CSF administration include myelofibrosis and leukemia.

- **Myelokathexis:** G-CSF is also sometimes used to treat the myelokathexis characteristic of WHIM syndrome to try to increase the number of neutrophils outside of the bone marrow, but G-CSF has no effect on lymphocytes and other types of white blood cells.

While the costs of managing the chronic impact of WHIM syndrome are unknown, the per-patient cost of treating primary immunodeficiencies that are similar to WHIM syndrome, based on drug costs alone, exceeds \$100,000 per year in the United States for therapies such as antibiotics, IVIG, SCIG and/or G-CSF, despite the limited effectiveness of these treatments. Beyond these estimated direct costs, other costs associated with direct and indirect management of the disease, such as repeated immunization, physician visits, or hospitalizations, have not been quantified but are likely to be significant. We believe that there is a significant need for a treatment targeting the underlying excessive signaling caused by genetic variations to the CXCR4 receptor, which is the established cause of WHIM syndrome.

Our approach to treating WHIM syndrome involves addressing the underlying cause of the disease by blocking CXCR4 signaling using mavorixafor, which has been shown to bind to the CXCR4 receptor in a manner that inhibits the receptor from being stimulated by CXCL12, enabling white blood cells to properly mature and release into the bloodstream and improving immune cell numbers and function.

Clinical Development of Mavorixafor in WHIM Syndrome

In January 2017, we initiated a Phase 2 clinical trial of mavorixafor for the treatment of people with WHIM syndrome. This trial was an open-label, dose-escalation trial in eight WHIM patients conducted at two sites in the United States and Australia pursuant to an Investigational New Drug (“IND”) application that we submitted to the U.S. Food and Drug Administration (“FDA”) in June 2016.

The primary objective of the Phase 2 clinical trial was to determine the safety and tolerability of mavorixafor and to determine the dose of mavorixafor for exploration in a pivotal Phase 3 clinical trial. The secondary objective of the Phase 2 trial was to evaluate the potential efficacy of mavorixafor in people with WHIM syndrome by measuring biomarkers, specifically absolute neutrophil (“ANC”) and lymphocyte (“ALC”) counts, over 24-hour dosing cycles. The frequency of infections, antibiotic use, hospitalizations, severity of warts lesions, and vaccine titer levels, among other metrics, were also examined. To be included in the trial, participants must have had a confirmed genetic diagnosis of WHIM syndrome, be at least 18 years of age, and have a neutrophil count equal to or less than 400 cells per microliter or a lymphocyte count equal to or less than 650 cells per microliter.

In the trial, participants received escalating doses of mavorixafor starting at 50 mg once daily to up to 400 mg once daily. Participants were dose-escalated from their starting dose based on an in-hospital 24-hour measurement of ANC and ALC above or below the pre-defined target thresholds of 600 cells per microliter and 1,000 cells per microliter, respectively.

We completed the dose-titration portion of the Phase 2 clinical trial in March 2018 and, based on the reported results, the Data Review Committee recommended the Phase 3 dose of 400 mg administered orally once daily. The choice of time above threshold for absolute neutrophil count (“TAT-ANC”), defined as the number of hours during which the absolute neutrophil count is raised above a 500 cells per microliter threshold, was selected as the primary endpoint of the Phase 3 clinical trial.

Following completion of the dose-titration portion of the Phase 2 clinical trial, participants were allowed to continue on study drug in a Phase 2 open-label extension trial. In June 2020, we announced the following positive data from the open-label extension portion of the Phase 2 clinical trial:

- Sustained, dose-dependent increases in white blood cells, ANC, and ALC were achieved; higher doses of mavorixafor were shown to increase the TAT-ANC at least 4.5-fold versus the TAT-ANC at lower doses.
- These long-term hematological improvements correlated with fewer infections and reduced numbers of cutaneous warts.
- A decreased yearly infection rate from 4.63 [95%CI 3.3,6.3] events in the 12 months prior to the trial, to 2.27 [95%CI 1.4, 3.5] events when treated with mavorixafor at higher doses once daily; notably, deeper reductions in yearly infection rates correlated with increased time on treatment.
- The participants with cutaneous warts on hands and/or feet at baseline achieved an average 75% reduction in the number of warts.
- Mavorixafor was well tolerated for the extended duration of up to more than two years without any attributable serious adverse effects.

In December 2021, we announced the following additional data from the Phase 2 open-label extension trial of mavorixafor in people with WHIM syndrome:

- Mavorixafor continued to show durable increases in neutrophils, lymphocytes, and monocytes, sustained improvements in infections and warts, and was well tolerated (median treatment duration = 148.4 weeks).
- Decreases in mean annualized infection rates correlated well with TAT-ANC.

- Standardized participant interviews revealed that long-term treatment with mavoxixafor was well tolerated and continued to demonstrate beneficial treatment effects, including decreased frequency, severity, and duration of infections and fewer hospital/doctor visits.

In June 2019, we initiated 4WHIM, a pivotal, global, randomized, double-blind, placebo-controlled, multicenter Phase 3 clinical trial designed to evaluate the efficacy and safety of mavoxixafor in people with genetically confirmed WHIM syndrome. Originally designed to enroll 18-28 patients, the trial achieved full enrollment in September 2021, with 31 participants aged 12 and older receiving either 200-400 mg mavoxixafor or placebo orally once daily for 52 weeks; all participants then became eligible to receive treatment with mavoxixafor in an open-label trial extension.

The primary endpoint of the 4WHIM trial is a clinically relevant reduction of duration of severe neutropenia as measured by the increase in TAT-ANC (500 cells per microliter) in peripheral blood. Secondary endpoints include time above threshold-absolute lymphocyte count (TAT-ALC) of $\geq 1,000$ cells per microliter over a 24-hour period, a composite clinical efficacy endpoint for mavoxixafor based on total infection score and total wart change score, total wart change score for mavoxixafor based on central blinded, independent review of 3 target skin regions, total infection score for mavoxixafor based on number and severity of infections adjudicated by a blinded, independent adjudication committee; and a number of quality-of-life measurements and other exploratory endpoints.

In November 2022, we reported positive top-line results from the Phase 3 4WHIM trial:

- 4WHIM met its primary endpoint, with mavoxixafor achieving clinical and statistical superiority over placebo ($P < 0.0001$) when measuring the length of time that participants' ANC remained above a clinically meaningful threshold of 500 cells per microliter (severe neutropenia), over 24-hour periods at 4 time points throughout the 52-week trial.
- 4WHIM also met a key secondary endpoint, with mavoxixafor achieving clinical and statistical superiority over placebo ($P < 0.0001$) when measuring the length of time that participants' ALC remained above a clinically meaningful threshold of 1,000 cells per microliter (lymphopenia), over 24-hour periods at 4 time points throughout the 52-week trial.
- Mavoxixafor was generally well tolerated in the trial, with no treatment-related serious adverse events reported and no discontinuations for safety events.

Additional data review and analysis of the secondary and exploratory endpoints of the 4WHIM trial are ongoing, with plans to present detailed results at a medical meeting in the second quarter of 2023. Given these positive results to date, we are targeting submission to the FDA of a New Drug Application ("NDA") early in the second half of 2023, with the goal of obtaining approval for mavoxixafor for the treatment of people in the United States, aged 12 and older, with WHIM syndrome.

Mavoxixafor has received multiple special designations from global regulatory authorities in WHIM syndrome, including Breakthrough Therapy Designation, Fast Track Designation, and Rare Pediatric Designation in the United States, and Orphan Drug Status in both the United States and European Union. In addition, upon approval of an NDA, we are eligible to receive a Priority Review Voucher ("PRV") as a result of mavoxixafor's Rare Pediatric Designation in the United States.

About Chronic Neutropenic Disorders

Due to its demonstrated ability to durably elevate levels of circulating white blood cells across multiple clinical trials, we believe that mavoxixafor may be useful in the treatment of people with a variety of chronic neutropenic disorders.

Chronic neutropenia is defined as periods lasting more than three months persistently or intermittently where there are abnormally low levels of neutrophils circulating in the blood, and may be idiopathic (of unknown origin), cyclic (episodes typically occurring every three weeks), or congenital (of genetic causation). Similar to WHIM syndrome, chronic neutropenia disorders are rare blood conditions similarly characterized by increased risks of infections and cancer due to abnormally low levels of neutrophils in the body. In all cases, the CXCL12/CXCR4 pathway is the key regulator of neutrophil release from the bone marrow.

The incidence and prevalence of chronic neutropenic disorders are not well established. In December 2022, we presented results from what we believe was the first study examining the prevalence of chronic neutropenia disorders (including idiopathic, cyclic, and congenital neutropenia) in the United States; we believe that determining the estimated projected prevalence of chronic neutropenic disorders is a key step to understanding the extent of existing unmet medical needs in this patient population.

- Using a retrospective analysis of a large U.S. claims database, the analysis included people with a diagnosis code for neutropenia during the calendar years 2018, 2019, and 2021 (the year 2020 was excluded from this analysis owing to anticipated reduced claims during the COVID-19 pandemic).
- People with a diagnostic, procedural, or product code for neutropenia resulting from secondary causes including chemotherapy, drug exposure, infection, solid organ transplantation, myelodysplastic syndrome, and end-stage renal disease within 24-month period prior to selection were excluded.
- A 13- to 24-month lookback period prior to index date was used to confirm chronic status.

- The analysis used longitudinal prescription data and office-based claims data from an IQVIA claims database that included 93% of retail prescription claims, 77% of mail-in prescription claims, and had more than 1.5 billion office-based claims per year.
- This retrospective analysis projected that in 2021, up to 48,000 people in the United States were living with a diagnosis of chronic neutropenia, with the most common type of chronic neutropenic disorder being idiopathic (~40,000), followed by cyclic (~5,000), and congenital (~3,000), and with the majority of affected people being female adults.

In 2022, we also completed an electronic medical records study to better understand the risk of serious or severe infection in people with chronic neutropenia in the United States, analyzing the medical records of 44 healthcare organizations treating approximately 66 million patients. The analysis examined patients who had experienced at least two Serious Infections Events (“SIEs”) following documentation of chronic neutropenia in each calendar year compared with those who did not have neutropenia. SIEs are defined as infections requiring hospitalization or intravenous antibiotics or that result in disability or death.

- The results of this analysis indicated that the incidence rate of SIEs per 100,000 person days was increased for all levels of chronic neutropenia: it was two times greater for patients with any chronic neutropenia (ANC less than 1,500 cells per microliter) and four times greater for patients with severe congenital neutropenia (ANC less than 500 cells per microliter).
- The risk of serious infection increased with the worsening of neutropenia.
- Approximately 25% of patients with chronic neutropenia had at least 2 SIEs in the latest calendar year examined, which was 2019.

People living with chronic neutropenia have few treatment options and may be treated with G-CSF, an injectable therapy approved in the United States for the treatment of severe, chronic neutropenia. G-CSF is used to stimulate the bone marrow to produce neutrophils. Side effects of G-CSF include disabling bone pain, which can be more severe in certain age groups. Additional, less common, treatment-limiting complications of chronic G-CSF administration include myelofibrosis and leukemia. In chronic neutropenia cases that are unresponsive to G-CSF, or if leukemia has developed, bone marrow transplants have been made with varying degrees of success. Bone marrow transplantation is often applied to severe neutropenia from bone marrow failure. Bone marrow transplants bring additional risks into the management of the disorders.

Clinical Development of Mavorixafor in Chronic Neutropenic Disorders

In 2022, we conducted a proof-of-concept Phase 1b open-label, multicenter study designed to assess the safety and tolerability of oral mavorixafor, with or without injectable G-CSF, in participants with chronic neutropenic disorders, including idiopathic, cyclic, and congenital neutropenia. Participants received a single dose of 400 mg oral mavorixafor to assess the magnitude of treatment response.

In September 2022, we announced positive results from the Phase 1b clinical trial:

- A total of 25 participants were enrolled in the study.
- 100% of study participants responded to treatment with a single dose of 400 mg of mavorixafor, alone or dosed concurrently with G-CSF:
 - Participants achieved a mean ANC increase at peak of >3,000 cells per microliter.
 - Consistent responses were seen across all of the chronic neutropenic disorders studied – idiopathic, cyclic, and congenital neutropenia.
- All neutropenic participants (n=14) reached normalized ANC levels (>1,500 cells per microliter):
 - When assessed as a monotherapy in participants with severe chronic neutropenia who were not being treated with G-CSF (n=6), a single dose of mavorixafor led to normalized ANC levels in all participants within 2 hours, with a mean ANC increase at peak of ~2,500 cells per microliter.
 - When assessed in participants with moderate or severe neutropenia, despite being treated with G-CSF (n=8), 100% reached normalized ANC levels, suggesting the potential of mavorixafor to both normalize the neutrophil counts in patients with partial response to G-CSF and also to potentially enable the reduction or elimination of G-CSF dosing.
- When assessed in participants with chronic neutropenia with normalized ANC counts on chronic G-CSF (n=11), all participants experienced a consistent and sustained increase in ANC, suggesting mavorixafor’s potential to reduce or possibly eliminate G-CSF treatment in these patients.
- Mavorixafor was well tolerated in the study; all treatment-related adverse events were deemed to be low grade, consistent with previous clinical studies in WHIM syndrome, and no treatment-related serious adverse events were reported.

Following these positive results, an amendment to the Phase 1b clinical trial was initiated aiming to evaluate the use of daily oral mavorixafor with or without injectable G-CSF for up to 6 months in participants with chronic neutropenic disorders as a Phase 2 clinical trial. The Phase 2 trial is expected to assess the durability of ANC responses, the potential of mavorixafor to enable patients to taper down dosing with G-CSF, and to evaluate the tolerability of mavorixafor in combination with G-CSF in chronic use. Participants are now being enrolled in this Phase 2 clinical trial and we expect to provide an update on clinical results in the

second or third quarter of 2023.

Concurrent with this Phase 2 trial execution, we are advancing our plans to conduct a Phase 3 program of mavorixafor in people with certain chronic neutropenic disorders in the event the Phase 2 results are positive. We expect this trial will be a randomized, placebo-controlled trial assessing the safety and efficacy of mavorixafor, with or without concomitant G-CSF, in people with idiopathic, cyclic, or congenital neutropenia. We expect to provide more clarity on the scope and timing of this potential clinical program in the second or third quarter of 2023.

Oncology Programs

In previous clinical and research studies, CXCR4 antagonism has been proven to increase the maturation and mobilization of white blood cells in all those dosed, including healthy volunteers, increase circulating neutrophils, lymphocytes, and monocytes, reduce bacterial and viral infections, and reduce lymphoma burden in combination with approved oncology therapeutics.

As a result of these previous studies, we conducted several clinical programs exploring the potential utility of mavorixafor in the treatment of certain cancers. Any further development of mavorixafor or other pipeline candidate(s) for any oncology indication will be subject to completion of a strategic partnership.

Mavorixafor in Waldenström's macroglobulinemia

Waldenström's is a rare form of non-Hodgkin's lymphoma and B-cell lymphoproliferative disorder most often caused by genetic variations in an immune-signaling gene called MYD88. Approximately 30-40% of people with Waldenström's have been shown to have a second genetic variation, a somatic WHIM-like activating variation in the CXCR4 gene in the cancer cells that define this rare form of lymphoma. Patients with the CXCR4 genetic variation have higher serum immunoglobulin M ("IgM") levels and greater incidence of symptomatic hyperviscosity. These patients also have a worse prognosis and weaker responses to treatment with Bruton tyrosine kinase ("BTK") inhibitors.

In December 2022, we completed a Phase 1b, open-label, multicenter, single-arm study evaluating the safety and efficacy of mavorixafor in combination with the BTK inhibitor ibrutinib in adult participants (either treatment naïve or relapsed/refractory) with Waldenström's and confirmed MYD88 and CXCR4 genetic variations. The Phase 1b clinical trial examined intra-patient dose escalation, safety, pharmacokinetics, and pharmacodynamics of mavorixafor plus ibrutinib in participants aged 18 years or older.

Interim results of the clinical trial were announced in August 2022; full clinical trial results are expected to be submitted to an appropriate medical journal for publication in the future. As of June 2022:

- A total of 16 participants were enrolled; all were dosed with oral, once-daily doses of ibrutinib (420 mg) and escalating doses (200 mg, 400 mg, 600 mg) of oral mavorixafor, also once daily.
- Ten of the 11 evaluable participants (91%) had achieved a major response ("MR") to therapy, or a greater than 50% reduction in serum IgM from baseline:
 - In relapsed/refractory participants, 7 of 7 (100%) achieved a MR.
 - In treatment-naïve patients, 3 of 4 (75%) achieved a MR.
- Adding mavorixafor to ibrutinib was associated with a higher MR rate at 3, 6, 9, 12, and 24 months compared to previously reported MR rates achieved with ibrutinib monotherapy.
- In addition, patients achieved elevations in ANC, with no neutropenic events reported; patients also experienced fewer infections over time with chronic dosing.
- No major safety signals had been identified in the trial as of the data cut-off; mavorixafor in combination with ibrutinib showed a safety profile similar to ibrutinib monotherapy (N=16, including 8 patients escalated to the 600 mg dose of mavorixafor).

The Phase 1b clinical trial of mavorixafor in Waldenström's macroglobulinemia trial was conducted as part of a collaboration with The Leukemia & Lymphoma Society ("LLS") to accelerate the development of mavorixafor for the treatment of Waldenström's. Mavorixafor was selected for LLS's Therapy Acceleration Program®, a strategic initiative where LLS builds business alliances and collaborations with biotechnology companies and academic researchers to speed the development of new therapies for blood cancers.

In June 2022, mavorixafor was granted Orphan Drug Designation by the FDA for the treatment of patients with Waldenström's macroglobulinemia, regardless of CXCR4 genetic variant status.

Mavorixafor in Immuno-Oncology Indications

In solid tumors, the tumor micro-environment ("TME") consists of the tumor cells and cancer associated fibroblasts ("CAFs"), each of which overproduce growth factors and chemokines to support immune-suppression and malignant cell proliferation and growth. Evidence suggests that the pro-tumor signals between tumor cells and CAFs occur, in part, through chemokine signaling, including through the over-production of CXCL12.

The CXCL12/CXCR4 pathway has been shown to be overstimulated in more than 20 solid and blood-derived tumor types. Excessive stimulation of CXCR4 due to high concentrations of CXCL12 influences the trafficking of immune cells, including myeloid-derived suppressor cells (“MDSCs”), CD4+ regulatory T cells (“Tregs”), CD8+ T cells (“killer T cells”), and mature dendritic cells. We believe that blocking CXCR4 overstimulation can lead to improved immune-cell trafficking and increase the absolute number of CD8+ T-cells, thereby also increasing the ratio of CD8+ T-cells to Tregs in the TME, turning the TME from an immunosuppressive environment to an immunostimulatory one.

Previously, we completed three clinical trials in solid tumors (two in clear cell renal cell carcinoma, one in melanoma) to explore the impact of mavorixafor on relevant tumor biomarkers and clinical responses. In all studies, combination of mavorixafor with standard of care proved to be well tolerated and showed favorable impact on key immune-response biomarkers (e.g. increased proliferation of CD8+ T-cells and CD8+ T-cells to Treg ratios in the TME) and improvement in clinical metrics (response rates) vs. historical controls of single-agent standards of care.

Ongoing trials in triple-negative breast cancer are being undertaken by Abbisko, our strategic partner for development and commercialization in greater China. Future development and potential commercialization of mavorixafor in potential immuno-oncology indications in markets outside of greater China will be pursued only as part of additional potential strategic collaboration(s).

Competition

The pharmaceutical and biotechnology industries are characterized by rapidly advancing technologies, intense competition, and a strong emphasis on proprietary products. We face potential competition from many different sources, including major pharmaceutical, specialty pharmaceutical and biotechnology companies, academic institutions, governmental agencies, and public and private research institutions. Any product candidates that we successfully develop and commercialize will compete with existing therapies and new therapies that may become available in the future.

Many of our competitors may have significantly greater financial resources and expertise in research and development, manufacturing, preclinical testing, conducting clinical trials, obtaining regulatory approvals, and marketing approved products than we do. Other firms also compete with us in recruiting and retaining qualified scientific and management personnel and establishing clinical trial sites and patient enrollment for clinical trials, as well as in acquiring technologies complementary to, or necessary for, our programs. Mergers and acquisitions in the pharmaceutical, biotechnology, and diagnostic industries may result in even more resources being concentrated among a smaller number of our competitors. Smaller or early stage companies may also prove to be significant competitors with us, particularly through collaborative arrangements with large and established companies.

Our commercial opportunities could be reduced or eliminated if our competitors develop and commercialize therapeutics that are safer, more effective, have fewer or less severe side effects, are more convenient or are less expensive than any products that we may develop. Our competitors also may obtain marketing approvals for their products more rapidly than we may obtain approval for our products, which could result in our competitors establishing a strong market position before we are able to enter the market. In addition, our ability to compete may be affected because in some cases insurers or other third-party payors, including government programs, seek to encourage the use of generic products. This may have the effect of making branded products less attractive to buyers from a cost perspective.

We are aware of other companies that are developing CXCR4 inhibitors that are in a similar stage of development as mavorixafor, including BioLineRx (motixafortide), Noxxon (NOXA12), Upsher-Smith, Polyphor (Balixafortide), and Glycomimetics (GMI1359). To our knowledge, there do not appear to be any competitors with programs in development for WHIM syndrome or chronic neutropenia. With respect to chronic neutropenia, filgrastim injections (human G-CSF) and two biosimilars (Zarxio and Nivestym) are FDA approved to reduce the incidence and duration of after-effects of severe neutropenia (e.g. fever, infections, oropharyngeal ulcers) in symptomatic patients with severe neutropenia.

In Waldenström’s, there are several treatment approaches currently being developed, including targeted therapies and immunotherapies (as monotherapies and combination therapies), chemotherapy, stem cell transplantation, and cancer vaccines. To our knowledge, only mavorixafor is targeting the CXCR4 pathway. Development of a Bristol Myers’ anti-CXCR4 antibody was discontinued.

Manufacturing

We do not own or operate, and currently have no plans to establish, manufacturing facilities for the production of clinical or commercial quantities of mavorixafor or any of our other product candidates. We currently rely, and expect to continue to rely, on third parties for the manufacture of any of our product or product candidates.

We currently have a master services agreement (“the Aptuit Agreement”) in place with Aptuit (Oxford) Ltd (“Aptuit”), pursuant to which Aptuit develops and manufactures the active pharmaceutical ingredient (“API”) for mavorixafor. The term of the Aptuit Agreement expires in February 2024 unless terminated by us and/or Aptuit. Aptuit is our sole supplier for mavorixafor drug substance and is currently manufacturing mavorixafor drug substance at a commercially relevant scale to support our ongoing and anticipated future supply needs.

We also have a master services agreement in place with Catalent Inc., formerly Mayne Pharma Inc. (“Catalent”), which is our sole manufacturer for the final capsule drug product formulation of mavorixafor. The term of the master services agreement with Catalent expires on September 10, 2023, and may be terminated by (1) us upon 30 days-notice to Catalent or (2) by either party following a material breach by the other party that remains uncured for 30 days.

We obtain the supplies of our drug products from Aptuit and Catalent pursuant to typical industry standard clinical supply agreements. We believe that both manufacturers have the capability and capacity to manufacture currently projected clinical trial supply and commercial volumes of mavorixafor. We expect to extend both of these manufacturing agreements beyond their current expiration dates.

Sales and Marketing

We intend to build a commercial infrastructure to support sales of any of our approved products. We expect to manage sales, marketing and distribution through internal resources and third-party relationships. While we may commit significant financial and management resources to commercial activities, we will also consider collaborating with one or more pharmaceutical companies to enhance our commercial capabilities.

License Agreements

License Agreement with Genzyme

In July 2014, we entered into a license agreement with Genzyme, a wholly owned subsidiary of Sanofi, pursuant to which we were granted an exclusive license to certain patent applications and other intellectual property owned or controlled by Genzyme related to the CXCR4 receptor to develop and commercialize products containing licensed compounds, including but not limited to mavorixafor. Genzyme has retained the non-exclusive right to conduct preclinical research involving compounds in any field, including any fields licensed to us, but has not retained rights to conduct any clinical development or commercialization of those compounds identified in the agreement in any of the fields licensed to us. We are primarily responsible for the preparation, filing, prosecution and maintenance of all patent applications and patents covering the intellectual property licensed to us under the agreement at our sole expense.

We are obligated to use commercially reasonable efforts to develop and commercialize licensed products for use in the field in the United States and at least one other major market country. We have the right to grant sublicenses of the licensed rights that cover mavorixafor to third parties. If we wish to grant a sublicense to any licensed product other than mavorixafor, we are obligated to first offer the sublicense to Genzyme. If Genzyme expresses written interest for the sublicense, then we will negotiate exclusively with Genzyme for a certain stated period to obtain a license to such rights, after which Genzyme shall have no further rights with respect to such licensed product and we will be free to negotiate a sublicense with respect to such licensed product with any third party.

We are obligated to pay Genzyme milestone payments in the aggregate amount of up to \$25 million, contingent upon our achievement of certain late-stage regulatory and sales milestones with respect to licensed products, and tiered royalties based on net sales of licensed products that we commercialize under the Genzyme agreement. Our obligation to pay royalties for each licensed product expires on a country-by-country basis on the latest of (i) the expiration of licensed patent rights that cover that licensed product in that country, (ii) the expiration of regulatory exclusivity in that country and (iii) ten years after the first commercial sale of such licensed product in that country. Royalty rates are subject to reduction under the agreement in specified circumstances, including in any country if we are required to obtain a license from any third party to the extent our patent rights might infringe the third party’s patent rights, if a licensed product is not covered by a valid claim in that country or if sales of generic products reach certain thresholds in that country. Sublicenses that we enter into under the Genzyme agreement, including our license agreement with Abbisko obligate us to pay Genzyme a percentage of certain upfront, maintenance fees, milestone payments and royalty payments paid to us by the sublicensee.

The term of the Genzyme Agreement will continue until the later of the expiration of the last to expire valid claim of the patents licensed under the agreement that cover any licensed product, the expiration of regulatory exclusivity applicable to any licensed product and 10 years from the date of first commercial sale of any licensed product. Either we or Genzyme may terminate the Genzyme Agreement in the event of the bankruptcy or uncured material breach by the other party. Genzyme may terminate the Genzyme Agreement if we or our affiliates initiate a patent challenge of the patents licensed under the agreement. We may terminate the Genzyme Agreement immediately upon notice to Genzyme if we reasonably believe that the development or commercialization of a licensed compound or product under the Genzyme agreement would result in a material safety issue for

patients.

License Agreement with Georgetown University

In December 2016, we entered into a license agreement with the Georgetown University (“Georgetown”) pursuant to which we obtained an exclusive, worldwide license to practice certain methods, and to make, have made, use, sell, offer for sale and import products, covered by licensed patent rights co-owned by Georgetown. The rights licensed to us are for all therapeutic, prophylactic and diagnostic uses in all disease indications in humans and animals. We have the right to grant sublicenses of the licensed rights to third parties to the extent consistent with the terms of the Georgetown agreement.

Under the terms of the Georgetown agreement we paid a one-time only, upfront fee of \$50 thousand, and we may be required to pay milestone payments of up to an aggregate of \$800 thousand related to commercial sales of a licensed product. We are responsible for all patent prosecution costs incurred with respect to the licensed patents. We are obligated under the agreement to use commercially reasonable efforts to develop and commercialize licensed product, to make licensed product reasonably available to the public, to obtain government approvals for licensed product and to market licensed product in quantities sufficient to meet the market demand.

The term of the Georgetown agreement will continue until the expiration of the last valid claim within the patent rights covering the licensed products. Georgetown may terminate the Georgetown agreement or convert our license to non-exclusive in the event (i) we fail to pay any amount and fail to cure such failure within 30 days after receipt of notice, (ii) we default in our obligation to obtain and maintain insurance and fail to remedy such breach within 45 days after receipt of notice, (iii) we declare insolvency or bankruptcy or (iv) we materially default in the performance of any material obligations under the Georgetown agreement which is not cured within a certain period from the date of written notice of such default. We may terminate the Georgetown agreement at any time upon at least 60 days’ written notice.

License Agreement with Beth Israel Deaconess Medical Center

In December 2016, we entered into a license agreement with Beth Israel Deaconess Medical Center (“BIDMC”) pursuant to which we obtained an exclusive, worldwide license to make, have made, use, sell, offer for sale and import of licensed products and certain processes covered by licensed patent rights co-owned by BIDMC and a nonexclusive royalty-free right to use certain information pertaining to any invention claimed in the licensed patents that is owned by BIDMC to develop, make, have made, use, have used, sell, have sold and commercialize such licensed products and processes. The rights licensed to us are for all fields of use. We have the right to grant sublicenses of the licensed rights to third parties to the extent consistent with the terms of the BIDMC agreement.

Under the terms of the BIDMC agreement we paid a one-time only, upfront fee of \$20 thousand and we are responsible for all future patent prosecution costs.

The term of the BIDMC agreement will continue until the expiration of the last valid claim within the patent rights covering the licensed product. BIDMC may terminate the agreement in the event (i) we fail to pay any amount and fail to cure such failure within 15 days after receipt of notice, (ii) the insurance coverage that we are obligated to maintain under the agreement is terminated and we fail to obtain replacement insurance within a certain period of time following notice to BIDMC, or (iii) we declare insolvency or bankruptcy. In addition, if we are in material breach of any material provisions of the BIDMC agreement and fail to remedy such breach within 60 days after receipt of notice, BIDMC may terminate the BIDMC agreement or terminate any licenses granted under the BIDMC agreement with respect to the country or countries in which such material breach has occurred. We may terminate the BIDMC agreement at any time upon at least 90 days’ written notice.

License Agreement with Dana Farber Cancer Institute

In November 2020, we entered into a license agreement with Dana Farber Cancer Institute (“DFCI”) pursuant to which we obtained a non-exclusive, worldwide license to use, make, have made, develop, market, import, distribute, sell and have sold licensed products and certain processes covered by licensed patent rights owned by DFCI. The rights licensed to us are for the therapeutic use of our CXCR4 antagonists for the treatment of Waldenström’s in combination with BTK inhibitors, including ibrutinib. We have the right to grant sublicenses of the licensed rights to third parties to the extent consistent with the terms of the DFCI agreement.

Under the terms of the DFCI agreement we paid a one-time, upfront fee of \$25 thousand and we are responsible for the reimbursement of certain future patent prosecution cost and the payment of an annual maintenance fee. We are obligated to pay DFCI milestone payments in the aggregate amount of up to approximately \$32 million, contingent upon our achievement of certain regulatory and sales milestones with respect to licensed products, and a flat royalty based on net sales of licensed products that we commercialize under the DFCI agreement.

The term of the DFCI agreement will continue until the expiration of the last valid claim within the patent rights covering the licensed product. DFCI may terminate the DFCI agreement in the event (i) we fail to pay any amount and fail to cure such failure within 30 days after receipt of notice, (ii) we cease to carry on our business with respect to the licensed products or process, (iii) the insurance coverage that we are obligated to maintain under the DFCI agreement is terminated and we fail to obtain replacement insurance within a certain period of time following notice to DFCI, (iv) we fail to comply with certain diligence obligations and cure any such default within 60 days after receipt of written notice, (v) we have granted a sublicense without notifying DFCI or on terms inconsistent with the terms required of sublicenses under the DFCI agreement, (vi) an officer of our company, an affiliate or sublicensee is convicted of a felony relating to the manufacture, use, sale or importation of a licensed product, (vii) we or any of our affiliates, sublicensees or sublicensees' affiliates initiate a patent challenge of the patents licensed under the DFCI agreement or assists others in doing so or (viii) we declare insolvency or bankruptcy. In addition, if we are in material breach of any material obligations under the DFCI agreement and fail to remedy such breach within 90 days after receipt of notice, DFCI may terminate the DFCI agreement or terminate any licenses granted under the agreement. We may terminate the DFCI agreement at any time upon at least 90 days' written notice.

Abbisko Agreement

In July 2019, we entered into a license agreement with Abbisko. Under the terms of the agreement, we granted Abbisko the exclusive right to develop, manufacture and commercialize mavorixafor in mainland China, Taiwan, Hong Kong and Macau. The agreement provides Abbisko with the exclusive rights in this territory to develop and commercialize mavorixafor in combination with checkpoint inhibitors or other agents in oncology indications. Pancreatic cancer, ovarian cancer and triple negative breast cancer will be explored initially. We retain the full rest-of-world rights to develop and commercialize mavorixafor outside of Greater China for all indications and the ability to utilize data generated pursuant to the Abbisko collaboration for rest-of-world development. In addition, Abbisko has the right of first refusal if we determine to pursue additional products in the Abbisko Territory, as defined in the agreement. We entered into a separate agreement in April 2020 whereby we will provide Abbisko with a clinical supply and, if the product is commercialized in the territory licensed by Abbisko, we intend to enter into a commercial supply of the licensed compound.

Pursuant to the agreement with Abbisko, upon the closing of a qualified financing of Abbisko, as defined in the agreement, which occurred in March 2020, Abbisko made a one-time, non-refundable, non-creditable financial milestone payment of \$3 million to us. We are also eligible to receive potential development, regulatory and commercial milestone payments of up to \$214 million, which will vary based on the ultimate sales, if any, of the approved licensed products. Upon commercialization of mavorixafor in the Abbisko Territory, we are eligible to receive a tiered royalty, with a percentage range in the low double-digits, on net sales of approved licensed products. Abbisko is obligated to use commercially reasonable efforts to develop and commercialize mavorixafor in the Abbisko Territory. Abbisko has responsibility for all activities and costs associated with the further development, manufacture and commercialization of mavorixafor in the Abbisko Territory.

Intellectual Property

Our ability to commercialize our product candidates depends in large part on our ability to obtain and maintain intellectual property protection for our product candidates, including mavorixafor, and our preclinical compounds and core technologies. Our policy is to seek to protect our intellectual property position by, among other methods, filing U.S. and foreign patent applications related to the technology, inventions and improvements that are important to the development and implementation of our business strategy. We also rely on trade secrets, know-how and continuing technological innovation to develop and maintain our proprietary position.

We file patent applications directed to our product candidates, preclinical compounds and related technologies to establish intellectual property positions on these compounds and their uses in disease. As of December 31, 2022, we owned or exclusively licensed 18 issued U.S. patents, 14 pending U.S. non-provisional patent applications, eight pending U.S. provisional patent application, and approximately 175 PCT and foreign patents and patent applications in the following foreign jurisdictions: Belgium, Brazil, Canada, China, European Patent Office, France, Germany, Great Britain, Hong Kong, India, Ireland, Italy, Israel, Japan, Lichtenstein, Mexico, Netherlands, New Zealand, Singapore, South Africa, Spain, Sweden and Switzerland.

As of December 31, 2022, our in-licensed intellectual property portfolio for mavorixafor included three issued U.S. patents and one pending U.S. patent application directed to mavorixafor, including one issued U.S. patent with claims directed to a crystalline salt form of mavorixafor, one issued U.S. patent directed to pharmaceutical compositions of mavorixafor in unit dosage form, and one issued U.S. patents directed to methods of making mavorixafor and key intermediates. These in-licensed patents are expected to expire between 2024 and 2027. We also had four issued U.S. patents directed to compositions and methods of making chemical compounds related to the X4P-001 program. Approximately 61 corresponding foreign patents directed to compositions of matter and related chemical compounds as well as methods of making and methods of use were issued or pending. All of the above patents and patent applications were exclusively licensed to us pursuant to the terms of the Genzyme agreement.

Additionally, we have filed our own patent applications with respect to the mavorixafor and X4P-002 product candidates. Some of these patent applications are co-owned with Genzyme, BIDMC or Georgetown, with their rights exclusively licensed to us. As of December 31, 2022, our independently generated intellectual property portfolio included seven granted U.S. patents, ten pending U.S. non-provisional patent applications, four pending U.S. provisional patent applications, and approximately 72 pending PCT and foreign patent applications related to our mavorixafor clinical programs in cancer and primary immunodeficiencies. In addition, we have four granted U.S. patents, four pending U.S. non-provisional patent applications, four pending provisional applications and approximately 38 pending PCT and foreign patent applications related to our preclinical compounds and X4P-002 in glioblastoma. Patents issuing from these applications, if any, are expected to expire between 2036 and 2043.

The term of individual patents depends upon the legal term of the patents in the countries in which they are obtained. In most countries, including the United States, the patent term is 20 years from the earliest filing date of a non-provisional patent application. In the United States, a patent's term may be lengthened by patent term adjustment, which compensates a patentee for administrative delays by the U.S. Patent and Trademark Office, (the "USPTO"), in examining and granting a patent, or may be shortened if a patent is terminally disclaimed over an earlier filed patent. The term of a U.S. patent that covers a drug or biological product may also be eligible for patent term extension when approval from the FDA is granted, provided statutory and regulatory requirements are met. In the future, if our product candidates receive approval from the FDA or foreign regulatory authorities, we expect to apply for patent term extensions on issued patents covering those products, depending upon the length of the clinical trials for each drug and other factors. There can be no assurance that any of our pending patent applications will issue or that we will benefit from any patent term extension or other favorable adjustment to the term of any of our patents.

As with other biotechnology and pharmaceutical companies, our ability to maintain and solidify our proprietary and intellectual property position for our product candidates, including mavorixafor, and our preclinical compounds, and our core technologies will depend on our success in obtaining effective patent claims and enforcing those claims if granted. However, patent applications that we may file or license from third parties may not result in the issuance of patents. We also cannot predict the breadth of claims that may be allowed or enforced in our patents. Any issued patents that we may receive in the future may be challenged, invalidated or circumvented. For example, prior to March 16, 2013, in the United States, patent applications were subject to a "first to invent" rule of law. Applications filed after March 16, 2013 (except for certain applications claiming the benefit of earlier-filed applications) are subject to a "first to file" rule of law.

Discoveries reported in the scientific literature often lag the actual discoveries, and patent applications in the United States and other jurisdictions are typically not published until 18 months after filing, or in some cases not at all. We cannot be certain that any existing or future application will be subject to the "first to file" or "first to invent" rule of law, that we were the first to make the inventions claimed in our existing patents or pending patent applications subject to the prior laws, or that we were the first to file for patent protection of such inventions subject to the new laws. If third parties prepare and file patent applications in the United States that also claim technology we have claimed in our patents or patent applications, we may have to participate in interference proceedings in the USPTO to determine priority of invention, which could result in substantial costs to us, even if the eventual outcome is favorable to us. In addition, because of the extensive time required for clinical development and regulatory review of a product candidate we may develop, it is possible that, before any of our product candidates can be commercialized, any related patent may expire or remain in force for only a short period following commercialization, thereby reducing any advantage of any such patent.

In addition to patents, we rely upon unpatented trade secrets, know-how, and continuing technological innovation to develop and maintain our competitive position. We seek to protect our proprietary information, in part, by using confidentiality agreements with our collaborators, scientific advisors, employees and consultants, and invention assignment agreements with our employees. We also have agreements requiring assignment of inventions with selected consultants, scientific advisors and collaborators. The confidentiality agreements are designed to protect our proprietary information and, in the case of agreements or clauses requiring invention assignment, to grant us ownership of technologies that are developed under those agreements.

Government Regulation and Product Approval

The FDA Approval Process

In the United States, pharmaceutical products are subject to extensive regulation by the FDA. The Federal Food, Drug, and Cosmetic Act, (the "FDCA"), and other federal and state statutes and regulations, govern, among other things, the research, development, testing, manufacture, storage, recordkeeping, approval, labeling, promotion and marketing, distribution, post-approval monitoring and reporting, sampling, and import and export of pharmaceutical products. Failure to comply with applicable U.S. requirements may subject a company to a variety of administrative or judicial sanctions, such as imposition of clinical holds, refusal by the FDA to approve pending NDAs, warning letters, product recalls, product seizures, total or partial suspension of production or distribution, injunctions, fines, refusals of government contracts, restitution, disgorgement, civil penalties and criminal prosecution.

Pharmaceutical product development in the United States typically involves preclinical or other nonclinical laboratory and animal tests and the submission to the FDA of an IND, which must become effective before clinical testing may commence. For commercial approval, the sponsor must submit adequate tests by all methods reasonably applicable to show that the drug is safe for use under the conditions prescribed, recommended or suggested in the proposed labeling. The sponsor must also submit substantial evidence, generally consisting of adequate, well-controlled clinical trials to establish that the drug will have the effect it purports or is represented to have under the conditions of use prescribed, recommended or suggested in the proposed labeling. In certain cases, the FDA may determine that a drug is effective based on one clinical study plus confirmatory evidence.

Nonclinical tests include laboratory evaluation of product chemistry, formulation and toxicity, as well as animal studies to assess the characteristics and potential safety and efficacy of the product. The conduct of the nonclinical tests must comply with federal requirements, including the FDA's good laboratory practices regulations and the U.S. Department of Agriculture's ("USDA's"), regulations implementing the Animal Welfare Act. The results of nonclinical testing are submitted to the FDA as part of an IND along with other information, including information about product chemistry, manufacturing and controls, and a proposed clinical trial protocol. Long-term nonclinical tests, such as animal studies of reproductive toxicity and carcinogenicity, may continue after the IND is submitted.

A 30-day waiting period after the submission of each IND is required prior to the commencement of clinical testing in humans. If the FDA has not imposed a clinical hold on the IND or otherwise commented or questioned the IND within this 30-day period, the clinical trial proposed in the IND may begin.

Clinical trials involve the administration of the investigational new drug to healthy volunteers or patients under the supervision of a qualified investigator. Clinical trials must be conducted: (i) in compliance with federal regulations, (ii) in compliance with GCP, an international standard meant to protect the rights and health of patients and to define the roles of clinical trial sponsors, administrators and monitors, and (iii) under protocols detailing the objectives of the trial, the parameters to be used in monitoring safety and the effectiveness criteria to be evaluated. Each protocol involving testing on U.S. patients and subsequent protocol amendments must be submitted to the FDA as part of the IND.

The FDA may order the temporary, or permanent, discontinuation of a clinical trial at any time or impose other sanctions if it believes that the clinical trial either is not being conducted in accordance with the FDA requirements or presents an unacceptable risk to the clinical trial patients. The trial protocol and informed consent information for patients in clinical trials must also be submitted to an institutional review board ("IRB") at each site where a trial will be conducted for approval. An IRB may also require the clinical trial at the site to be halted, either temporarily or permanently, for failure to comply with the IRB's requirements or may impose other conditions.

Clinical trials to support NDAs for marketing approval are typically conducted in three sequential phases, but the phases may overlap. In general, in Phase 1, the initial introduction of the drug into healthy human volunteers or, in some cases, patients, the drug is tested to assess metabolism, pharmacokinetics, pharmacological actions, side effects associated with increasing doses and, if possible, early evidence of effectiveness. Phase 2 usually involves trials in a limited patient population to determine the effectiveness of the drug for a particular indication, dosage tolerance and optimum dosage, and to identify common adverse effects and safety risks. If a compound demonstrates evidence of effectiveness and an acceptable safety profile in Phase 2 evaluations, Phase 3 trials are undertaken to obtain the additional information about clinical efficacy and safety in a larger number of patients, typically at geographically dispersed clinical trial sites, to permit the FDA to evaluate the overall benefit-risk relationship of the drug and to provide adequate information for the labeling of the drug. In most cases, the FDA requires two adequate and well-controlled Phase 3 clinical trials to demonstrate the efficacy of the drug. The FDA may, however, determine that a drug is effective based on one clinical trial plus confirmatory evidence. In some cases, the FDA may require post-market studies, known as Phase 4 studies, to be conducted as a condition of approval to gather additional information on the drug's effect in various populations and any side effects associated with long-term use. Depending on the risks posed by the drugs, other post-market requirements may be imposed.

After completion of the required clinical testing, an NDA is prepared and submitted to the FDA. FDA approval of the NDA is required before marketing of the product may begin in the United States. The NDA must include the results of all preclinical, clinical, and other testing and a compilation of data relating to the product's pharmacology, chemistry, manufacture, and controls. Under federal law, the submission of most NDAs is additionally subject to a substantial application user fee, subject to certain exceptions and waivers, such as for orphan-designated drugs.

The FDA has 60 days from its receipt of an NDA to determine whether the application will be accepted for filing based on the agency's threshold determination that it is sufficiently complete to permit substantive review. Once the submission is accepted for filing, the FDA begins an in-depth review. Under the performance goals established pursuant to the Prescription Drug User Fee Act the FDA aims to complete review of 90% of standard (non-priority) NDAs within 10 months filing and within six months for priority NDAs.

The FDA may also refer applications for novel drug products, or drug products that present difficult questions of safety or efficacy, to an advisory committee, which is typically a panel that includes clinicians and other experts, for review, evaluation and a recommendation as to whether the application should be approved. The FDA is not bound by the recommendation of an advisory committee, but it generally follows such recommendations. Before approving an NDA, the FDA will typically inspect one or more clinical sites to assure compliance with GCP. Additionally, the FDA will inspect the facility or the facilities at which the drug is manufactured. The FDA will not approve the product unless compliance with current GMP is satisfactory and the NDA contains data that provide substantial evidence that the drug is safe and effective in the indication studied.

After the FDA evaluates the NDA and the manufacturing facilities, it issues either an approval letter or a complete response letter. A complete response letter generally outlines the deficiencies in the submission and may require substantial additional testing, or information, in order for the FDA to reconsider the application. If, or when, those deficiencies have been addressed to the FDA's satisfaction in a resubmission of the NDA, the FDA will issue an approval letter.

An approval letter authorizes commercial marketing of the drug with specific prescribing information for specific indications. As a condition of NDA approval, the FDA may require a risk evaluation and mitigation strategy ("REMS") to help ensure that the benefits of the drug outweigh the potential risks. REMS can include medication guides, communication plans for health care professionals, and elements to assure safe use ("ETASU"). ETASU can include, but are not limited to, special training or certification for prescribing or dispensing, dispensing only under certain circumstances, special monitoring, and the use of patient registries. The requirement for a REMS can materially affect the potential market and profitability of the drug. Moreover, product approval may require substantial post-approval testing and surveillance to monitor the drug's safety or efficacy. Once granted, product approvals may be withdrawn if compliance with regulatory standards is not maintained or problems are identified following initial marketing.

The Hatch-Waxman Act

Orange Book Listing

In seeking approval for a drug through an NDA, applicants are required to list with the FDA each patent whose claims cover the applicant's product. Upon approval of a drug, each of the patents listed in the application for the drug is then published in the FDA's Approved Drug Products with Therapeutic Equivalence Evaluations, commonly known as the Orange Book. Drugs listed in the Orange Book can, in turn, be cited by potential generic competitors in support of approval of an abbreviated new drug application, or ANDA. An ANDA provides for marketing of a drug product that has the same active ingredients in the same strengths and dosage form as the listed drug and has been shown through bioequivalence testing to be bioequivalent to the listed drug. Other than the requirement for bioequivalence testing, ANDA applicants are not required to conduct, or submit results of, pre-clinical or clinical tests to prove the safety or effectiveness of their drug product. Drugs approved in this way are considered to be therapeutically equivalent to the listed drug, are commonly referred to as "generic equivalents" to the listed drug, and can often be substituted by pharmacists under prescriptions written for the original listed drug in accordance with state law.

The ANDA applicant is required to certify to the FDA concerning any patents listed for the approved product in the FDA's Orange Book. Specifically, the applicant must certify that: (i) the required patent information has not been filed; (ii) the listed patent has expired; (iii) the listed patent has not expired, but will expire on a particular date and approval is sought after patent expiration; or (iv) the listed patent is invalid or will not be infringed by the new product. The ANDA applicant may also elect to submit a section viii statement, certifying that its proposed ANDA labeling does not contain (or carve out) any language regarding the patented method-of-use, rather than certify to a listed method-of-use patent.

If the applicant does not challenge the listed patents, the ANDA application will not be approved until all the listed patents claiming the referenced product have expired.

A certification that the new product will not infringe the already approved product's listed patents, or that such patents are invalid, is called a Paragraph IV certification. If the ANDA applicant has provided a Paragraph IV certification to the FDA, the applicant must also send notice of the Paragraph IV certification to the NDA and patent holders once the ANDA has been accepted for filing by the FDA. The NDA and patent holders may then initiate a patent infringement lawsuit in response to the notice of the Paragraph IV certification. The filing of a patent infringement lawsuit within 45 days of the receipt of a Paragraph IV certification automatically prevents the FDA from approving the ANDA until the earlier of 30 months, expiration of the patent, settlement of the lawsuit, or a decision in the infringement case that is favorable to the ANDA applicant.

The ANDA application also will not be approved until any applicable non-patent exclusivity listed in the Orange Book for the referenced product has expired.

Exclusivity

Upon NDA approval of a new chemical entity, or NCE, which is a drug that contains no active moiety that has been approved by the FDA in any other NDA, that drug receives five years of marketing exclusivity during which time the FDA cannot receive any ANDA or 505(b)(2) application seeking approval of a drug that references a version of the NCE drug. Certain changes to a drug, such as the addition of a new indication to the package insert, are associated with a three-year period of exclusivity during which the FDA cannot approve an ANDA or 505(b)(2) application that includes the change.

An ANDA or 505(b)(2) application may be submitted one year before NCE exclusivity expires if a Paragraph IV certification is filed. If there is no listed patent in the Orange Book, there may not be a Paragraph IV certification and thus no ANDA or 505(b)(2) application may be filed before the expiration of the exclusivity period.

Five-year and three-year exclusivities do not preclude FDA approval of a 505(b)(1) application for a duplicate version of the drug during the period of exclusivity, provided that the 505(b)(1) applicant conducts or obtains a right of reference to all of the preclinical studies and adequate and well controlled clinical trials necessary to demonstrate safety and effectiveness.

Patent Term Extension

After NDA approval, owners of relevant drug patents may apply for up to a five-year patent extension. The allowable patent term extension is calculated as half of the drug's testing phase—the time between IND submission and NDA submission—and all of the review phase—the time between NDA submission and approval up to a maximum of five years. The time can be shortened if the FDA determines that the applicant did not pursue approval with due diligence. The total patent term after the extension may not exceed 14 years.

For patents that might expire during the application phase, the patent owner may request an interim patent extension. An interim patent extension increases the patent term by one year and may be renewed up to four times. For each interim patent extension granted, the post-approval patent extension is reduced by one year. The director of the USPTO must determine that approval of the drug covered by the patent for which a patent extension is being sought is likely. Interim patent extensions are not available for a drug for which an NDA has not been submitted.

Advertising and Promotion

Once an NDA is approved, a product will be subject to certain post-approval requirements. For instance, the FDA closely regulates the post-approval marketing and promotion of drugs.

Drugs may be marketed only for the approved indications and in accordance with the provisions of the approved labeling. Changes to some of the conditions established in an approved application, including changes in indications, labeling, or manufacturing processes or facilities, require submission and FDA approval of a new NDA or NDA supplement before the change can be implemented. An NDA supplement for a new indication typically requires clinical data similar to that in the original application, and the FDA uses the same procedures and actions in reviewing NDA supplements as it does in reviewing NDAs.

Adverse Event Reporting and GMP Compliance

Adverse event reporting and submission of periodic reports is required following FDA approval of an NDA. The FDA also may require post-marketing testing, known as Phase 4 testing, require a REMS special communications regarding the safety of the drug or heightened surveillance to monitor the effects of an approved product, or may place conditions on an approval that could restrict the distribution or use of the product. In addition, quality control, drug manufacture, packaging, and labeling procedures must continue to conform to GMP after approval. Drug manufacturers and certain of their subcontractors are required to register their establishments with the FDA and certain state agencies. Registration with the FDA subjects entities to periodic unannounced inspections by the FDA, during which the agency inspects manufacturing facilities to assess compliance with GMP. Accordingly, manufacturers must continue to expend time, money and effort in the areas of production and quality control to maintain compliance with GMP. Regulatory authorities may withdraw product approvals or request product recalls if a company fails to comply with regulatory standards, if it encounters problems following initial marketing or if previously unrecognized problems are subsequently discovered.

Pediatric Exclusivity and Pediatric Use

The Best Pharmaceuticals for Children Act, or BPCA, provides NDA holders a six-month period of exclusivity attached to any other exclusivity listed with FDA—patent or non-patent—for a drug if certain conditions are met. Conditions for pediatric exclusivity include a determination by the FDA that information relating to the use of a new drug in the pediatric population may produce health benefits in that population; a written request by the FDA for pediatric studies; and agreement by the applicant to perform the requested studies and the submission to the FDA, completion of the studies in accordance with the written request, and the acceptance by the FDA of the reports of the requested studies within the statutory timeframe.

In addition, under the Pediatric Research Equity Act, or PREA, NDAs or supplements to NDAs must contain data to assess the safety and effectiveness of the drug for the claimed indications in all relevant pediatric subpopulations and to support dosing and administration for each pediatric subpopulation for which the drug is safe and effective, unless the sponsor has received a deferral or waiver from the FDA. Unless otherwise required by regulation, PREA does not apply to any drug for an indication for which orphan designation has been granted. The sponsor or the FDA may request a deferral of pediatric studies for some or all of the pediatric subpopulations. A deferral may be granted for several reasons, including a finding that the drug is ready for approval for use in adults before pediatric studies are complete or that additional safety or effectiveness data need to be collected before the pediatric studies begin.

Orphan Drugs

Under the Orphan Drug Act, the FDA may grant orphan drug designation to drugs intended to treat a rare disease or condition—generally a disease or condition that affects fewer than 200,000 individuals in the United States (or affects more than 200,000 in the United States and for which there is no reasonable expectation that the cost of developing and making available in the United States a drug for such disease or condition will be recovered from sales of such drug in the United States). Orphan drug designation must be requested before submitting an NDA. After the FDA grants orphan drug designation, the generic identity of the drug and its potential orphan use are disclosed publicly by the FDA. Orphan drug designation does not convey any advantage in, or shorten the duration of, the regulatory review and approval process. The first NDA applicant to receive FDA approval for a particular active ingredient to treat a particular disease with FDA orphan drug designation is entitled to a seven-year exclusive marketing period in the United States for that product, for that indication. During the seven-year exclusivity period, the FDA may not approve any other applications to market the same drug for the same disease, except in limited circumstances, such as a showing of clinical superiority to the product with orphan drug exclusivity. If the FDA designates an orphan drug based on a finding of clinical superiority, the FDA must provide a written notification to the sponsor that states the basis for orphan designation, including “any plausible hypothesis” relied upon by the FDA. The FDA must also publish a summary of its clinical superiority findings upon granting orphan drug exclusivity based on clinical superiority.

Orphan drug exclusivity does not prevent the FDA from approving a different drug for the same disease or condition, or the same drug for a different disease or condition. Among the other benefits of orphan drug designation are tax credits for certain research and a waiver of the NDA application user fee.

Breakthrough Designation

A product can be designated as a breakthrough therapy by FDA if it is intended to treat a serious or life-threatening condition and preliminary clinical evidence indicates that it may demonstrate substantial improvement over existing therapies on one or more clinically significant endpoints. A sponsor may request that a product candidate be designated as a breakthrough therapy concurrently with the submission of an IND or any time before an end-of-Phase-2 meeting, and the FDA must determine if the product candidate qualifies for breakthrough therapy designation within 60 days of receipt of the sponsor’s request. If so designated, the FDA shall act to expedite the development and review of the product’s marketing application, including by meeting with the sponsor throughout the product’s development, providing timely advice to the sponsor to ensure that the development program to gather pre-clinical and clinical data is as efficient as practicable, involving senior managers and experienced review staff in a cross-disciplinary review, assigning a cross-disciplinary project lead for the FDA review team to facilitate an efficient review of the development program and to serve as a scientific liaison between the review team and the sponsor, and taking steps to ensure that the design of the clinical trials is as efficient as practicable.

Rest of World Government Regulation

In addition to regulations in the United States, we are and will be subject, either directly or through our distribution partners, to a variety of regulations in other jurisdictions governing, among other things, clinical trials and any commercial sales and distribution of our products, if approved.

Whether or not we obtain FDA approval for a product, we must obtain the requisite approvals from regulatory authorities in non-U.S. countries prior to the commencement of clinical trials or marketing of the product in those countries.

Pharmaceutical Coverage, Pricing and Reimbursement

Sales of pharmaceutical products in the United States will depend, in part, on the extent to which the costs of the products will be covered by third-party payors, such as government health programs, and commercial insurance and managed health care organizations. These third-party payors are increasingly challenging the prices charged for medical products and services.

Significant uncertainty exists as to the coverage and reimbursement status of any drug products for which we obtain regulatory approval. In the United States, sales of any products for which we receive regulatory approval for commercial sale will depend in part on the availability of coverage and reimbursement from third-party payors. Third-party payors include government authorities, managed care providers, private health insurers and other organizations. Coverage and reimbursement policies for drug products can differ significantly from payor to payor as there is no uniform policy of coverage and reimbursement for drug products among third party payors in the United States. Third-party payors often rely upon Medicare coverage policy and payment limitations in setting their own reimbursement rates, but also have their own methods and approval process apart from Medicare determinations. The process for determining whether a payor will provide coverage for a drug product may be separate from the process for setting the reimbursement rate that the payor will pay for the drug product. Third-party payors may limit coverage to specific drug products on an approved list, or formulary, which might not include all of the FDA-approved drugs for a particular indication. Moreover, a payor's decision to provide coverage for a drug product does not imply that an adequate reimbursement rate will be approved. Adequate third-party reimbursement may not be available to enable us to maintain price levels sufficient to realize an appropriate return on our investment in product development.

Additionally, the containment of health care costs has become a priority of federal and state governments, and the prices of drugs have been a focus in this effort. The U.S. government, state legislatures and foreign governments have shown significant interest in implementing cost-containment programs, including price controls, utilization management and requirements for substitution of generic products. Adoption of price controls and cost-containment measures, and adoption of more restrictive policies in jurisdictions with existing controls and measures, could further limit our net revenue and results. If these third-party payors do not consider our products to be cost-effective compared to other available therapies, they may not cover our products after approval as a benefit under their plans or, if they do, the level of payment may not be sufficient to allow us to sell our products on a profitable basis.

The Medicare Prescription Drug, Improvement, and Modernization Act of 2003, or the MMA, imposed requirements for the distribution and pricing of prescription drugs for Medicare beneficiaries and included a major expansion of the prescription drug benefit under Medicare Part D. Under Part D, Medicare beneficiaries may enroll in prescription drug plans offered by private entities that provide coverage of outpatient prescription drugs. Part D is available through both stand-alone prescription drug benefit plans and prescription drug coverage as a supplement to Medicare Advantage plans. Unlike Medicare Parts A and B, Part D coverage is not standardized. Part D prescription drug plan sponsors are not required to pay for all covered Part D drugs, and each drug plan can develop its own drug formulary that identifies which drugs it will cover and at what tier or level. However, Part D prescription drug formularies must include drugs within each therapeutic category and class of covered Part D drugs, though not necessarily all the drugs in each category or class. Any formulary used by a Part D prescription drug plan must be developed and reviewed by a pharmacy and therapeutic committee.

Government payment for some of the costs of prescription drugs may increase demand for products for which we receive marketing approval. However, any negotiated prices for our products covered by a Part D prescription drug plan will likely be lower than the prices we might otherwise obtain. Moreover, while the MMA applies only to drug benefits for Medicare beneficiaries, private payors often follow Medicare coverage policy and payment limitations in setting their own payment rates. Any reduction in payment that results from the MMA may result in a similar reduction in payments from non-governmental payors.

Third-party payors are increasingly challenging the price and examining the medical necessity and cost-effectiveness of medical products and services, in addition to their safety and efficacy. In order to obtain coverage and reimbursement for any product that might be approved for sale, we may need to conduct expensive pharmacoeconomic studies in order to demonstrate the medical necessity and cost-effectiveness of our products, in addition to the costs required to obtain regulatory approvals. Our product candidates may not be considered medically necessary or cost-effective. If third-party payors do not consider a product to be cost-effective compared to other available therapies, they may not cover the product after approval as a benefit under their plans or, if they do, the level of payment may not be sufficient to allow a company to sell its products at a profit.

Healthcare Reform

The Patient Protection and Affordable Care Act, as amended by the Health Care and Education Reconciliation Act of 2010, collectively, the ACA, was enacted with the goal of expanding coverage for the uninsured while at the same time containing overall health care costs. With regard to pharmaceutical products, among other things, the ACA expanded and increased industry rebates for drugs covered under Medicaid programs and made changes to the coverage requirements under the Medicare D program. There have been challenges to certain aspects of the ACA. For example, on June 17, 2021, the U.S. Supreme Court dismissed a challenge on procedural grounds that argued the ACA is unconstitutional in its entirety because the "individual mandate" was repealed by Congress. Prior to the U.S. Supreme Court ruling, on January 28, 2021, President Biden issued an executive order to initiate a special enrollment for purposes of obtaining health insurance coverage through the ACA marketplace. The executive order also instructed certain governmental agencies to review and reconsider their existing policies and rules that limit access to healthcare, including among others, reexamining Medicaid demonstration projects and waiver programs that

include work requirements, and policies that create unnecessary barriers to obtaining access to health insurance coverage through Medicaid or the ACA. In addition, on August 16, 2022, President Biden signed the Inflation Reduction Act of 2022 (“IRA”) into law, which among other things, extends enhanced subsidies for individuals purchasing health insurance coverage in ACA marketplaces through plan year 2025. The IRA also eliminates the “donut hole” under the Medicare Part D program beginning in 2025 by significantly lowering the beneficiary maximum out-of-pocket cost and creating a new manufacturer discount program. It is possible that the ACA will be subject to judicial or Congressional challenges in the future. It is unclear how any such challenges and the healthcare reform measures of the Biden administration will impact the ACA.

Also, there has been heightened governmental scrutiny recently over pharmaceutical pricing practices in light of the rising cost of prescription drugs and biologics. Such scrutiny has resulted in several Presidential executive orders, Congressional hearings and proposed and enacted federal and state legislation designed to, among other things, bring more transparency to product pricing, review the relationship between pricing and manufacturer patient programs, and reform government program reimbursement methodologies for products. For example, in July 2021, the Biden administration released an executive order, “Promoting Competition in the American Economy,” with multiple provisions aimed at prescription drugs. In response to Biden’s executive order, on September 9, 2021, HHS released a Comprehensive Plan for Addressing High Drug Prices that outlines principles for drug pricing reform and sets out a variety of potential legislative policies that Congress could pursue as well as potential administrative actions HHS can take to advance these principles. In addition, the IRA, among other things, (i) directs HHS to negotiate the price of certain high-expenditure, single-source drugs and biologics covered under Medicare, and subject drug manufacturers to civil monetary penalties and a potential excise tax by offering a price that is not equal to or less than the negotiated “maximum fair price” for such drugs and biologics under the law, and (ii) imposes rebates with respect to certain drugs and biologics covered under Medicare Part B or Medicare Part D to penalize price increases that outpace inflation. The IRA permits HHS to implement many of these provisions through guidance, as opposed to regulation, for the initial years. These provisions will take effect progressively starting in fiscal year 2023, although they may be subject to legal challenges. It is currently unclear how the IRA will be implemented but is likely to have a significant impact on the pharmaceutical industry. Further, the Biden administration released an additional executive order on October 14, 2022, directing HHS to submit a report on how the Center for Medicare and Medicaid Innovation can be further leveraged to test new models for lowering drug costs for Medicare and Medicaid beneficiaries. It is unclear whether this executive order or similar policy initiatives will be implemented in the future. Further, Congress is considering additional health reform measures. At the state level, legislatures have increasingly passed legislation and implemented regulations designed to control pharmaceutical and biological product pricing, including price or patient reimbursement constraints, discounts, restrictions on certain product access and marketing cost disclosure and transparency measures, and, in some cases, designed to encourage importation from other countries and bulk purchasing.

In addition, in some foreign countries, the proposed pricing for a drug must be approved before it may be lawfully marketed. The requirements governing drug pricing vary widely from country to country. For example, some E.U. jurisdictions operate positive and negative list systems under which products may only be marketed once a reimbursement price has been agreed. To obtain reimbursement or pricing approval, some of these countries may require the completion of clinical trials that compare the cost-effectiveness of a particular product candidate to currently available therapies. Other member states allow companies to fix their own prices for medicines but monitor and control company profits. Such differences in national pricing regimes may create price differentials between E.U. member states. There can be no assurance that any country that has price controls or reimbursement limitations for pharmaceutical products will allow favorable reimbursement and pricing arrangements for any of our products. Historically, products launched in the European Union do not follow price structures of the United States. In the European Union, the downward pressure on healthcare costs in general, particularly prescription medicines, has become intense. As a result, barriers to entry of new products are becoming increasingly high and patients are unlikely to use a drug product that is not reimbursed by their government.

Other Healthcare Laws and Compliance Requirements

Our current and future operations may subject us to various federal and state laws targeting fraud and abuse in the healthcare industry. These laws may impact, among other things, our research and proposed sales, marketing and education programs. In addition, we may be subject to patient privacy regulation by both the federal government and the states and foreign jurisdictions in which we conduct our business. The laws that may affect our ability to operate include:

- the federal Anti-Kickback Statute, which prohibits, among other things, persons from knowingly and willfully soliciting, receiving, offering or paying remuneration, directly or indirectly, to induce, or in return for, the purchase or recommendation of an item or service reimbursable under a federal healthcare program, such as the Medicare and Medicaid programs;
- federal civil and criminal false claims laws and civil monetary penalty laws, which prohibit, among other things, individuals or entities from knowingly presenting, or causing to be presented, claims for payment from Medicare, Medicaid, or other third-party payors that are false or fraudulent;
- the federal Health Insurance Portability and Accountability Act of 1996, or HIPAA, which created additional federal criminal statutes that prohibit, among other things, executing a scheme to defraud any healthcare benefit program and making false statements relating to healthcare matters;

- the federal transparency laws, including the federal Physician Payments Sunshine Act, that require drug manufacturers to disclose payments and other transfers of value provided to physicians, (currently defined to include doctors, dentists, optometrists, podiatrists and chiropractors), certain other healthcare professionals (such as physician assistants and nurse practitioners) and teaching hospitals, as well as ownership and investment interests held by physicians and their immediate family members;
- HIPAA, as amended by the Health Information Technology and Clinical Health Act, or HITECH, and its implementing regulations, which imposes certain requirements on “covered entities,” including certain healthcare providers, health plans, and healthcare clearinghouses, as well as their respective “business associates” that create, receive, maintain or transmit individually identifiable health information for or on behalf of a covered entity, and their covered subcontractors, with respect to safeguarding the privacy, security and transmission of individually identifiable health information; and
- Foreign and state law equivalents of each of the above federal laws, such as anti-kickback and false claims laws which may apply to items or services reimbursed by any third-party payor, including commercial insurers, state and local laws governing the disclosure of payments to health care professionals, state laws that require pharmaceutical companies to comply with the pharmaceutical industry’s voluntary compliance guidelines and the relevant compliance guidance promulgated by the federal government, state laws that require the reporting of information related to drug pricing, state and local laws requiring the registration of pharmaceutical sales representatives and state laws governing the privacy and security of health information in certain circumstances, many of which differ from each other in significant ways and may not have the same effect, thus complicating compliance efforts.

If our operations are found to be in violation of any of these laws or any other governmental regulations that may apply to it, we may be subject to significant civil, criminal and administrative penalties, damages, fines, imprisonment, exclusion from government funded healthcare programs, such as Medicare and Medicaid, and the curtailment or restructuring of our operations.

Human Capital Policies and Procedures

As of December 31, 2022, we had 70 full-time employees. Of these employees, 47 were engaged in research and development and 23 were engaged in selling, general and administrative functions. All of our employees are located in the United States or Vienna, Austria. We have no collective bargaining agreements with our employees and have not experienced any work stoppages. We consider our relationship with our employees to be good.

Human capital is critical to our success. Our overarching human capital resource strategy is to recruit, hire, incentivize and retain employees consistent with our stage of operations and strategic objectives. We believe we offer our employees compensation that is competitive and consistent with the markets in which we operate, namely the Greater Boston and the Vienna, Austria metropolitan areas. We supplement base cash employee compensation with awards of stock options and/or restricted stock units under our equity incentive plans. We review employee performance annually and our Compensation Committee approves associated merit increases and annual incentive bonus payments during the first quarter of the year annually. When needed, we augment our employee base with outside consultants who specialize in various fields.

Corporate Information

We were incorporated under the laws of the State of Delaware in 2010 under the name Arsanis Inc. Following the Merger with X4 Therapeutics Inc. (formerly X4 Pharmaceuticals Inc.) on March 13, 2019, we changed our name to X4 Pharmaceuticals, Inc. Our principal executive offices are located at 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134 and our telephone number is (857) 529-8300.

Available Information

We maintain a website at <http://www.x4pharma.com>. Our annual reports on Form 10-K, quarterly reports on Form 10-Q, proxy statements, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act are available free of charge on our website as soon as reasonably practicable after electronically filing such reports with the SEC. Such reports and other information may be accessed through the SEC’s website at www.sec.gov. Information contained in our website is not part of this or any other report that we file with or furnish to the SEC.

ITEM 1A. RISK FACTORS

An investment in our securities involves a high degree of risk. You should carefully consider the following information about these risks, together with the other information appearing elsewhere in this Annual Report, including our audited consolidated financial statements and related notes hereto, before deciding to invest in our common stock. The occurrence of any of the following risks could have a material adverse effect on our business, financial condition, results of operations and future growth prospects, or cause our actual results to differ materially from those contained in forward-looking statements we have made in this report and those we may make from time to time. In these circumstances, the market price of our common stock could decline, and you may lose all or part of your investment. We cannot assure you that any of the events discussed below will not occur.

Summary of Selected Risks Associated with Our Business

Our business faces significant risks and uncertainties. If any of the following risks are realized, our business, financial condition and results of operations could be materially and adversely affected. You should carefully review and consider the full discussion of our risk factors in the section titled "Risk Factors" in Part I, Item 1A of this Annual Report. Some of the more significant risks include the following:

- We have incurred significant losses and have not generated revenue from product sales since our inception. We expect to continue to incur losses for the foreseeable future, and we may never achieve or maintain profitability.
- Our liquidity position raises substantial doubt about our ability to continue as a going concern and we will require substantial additional funding. If we are unable to raise capital when needed, we could be forced to delay, reduce or eliminate any product development programs or commercialization efforts.
- Raising additional capital may cause dilution to our investors, restrict our operations or require us to relinquish rights to our technologies or product candidates. Future debt obligations may expose us to risks that could adversely affect our business, operating results and financial condition and may result in further dilution to our stockholders.
- We depend almost entirely on the success of our lead product candidate, mavorixafor, which we are developing for the potential treatment of chronic neutropenic disorders, including WHIM (Warts, Hypogammaglobulinemia, Infections, and Myelokathexis) syndrome and, contingent on a potential strategic partnerships, for the treatment of Waldenström's. We cannot be certain that we will be able to obtain regulatory approval for, or successfully commercialize, mavorixafor or any other product candidate.
- The regulatory review and approval processes of the FDA and comparable foreign regulatory authorities are lengthy, time-consuming and inherently unpredictable, and if we are ultimately unable to obtain regulatory approval for our product candidates, including mavorixafor, our business will be substantially harmed.
- We depend on license agreements with Genzyme, Beth Israel Deaconess Medical Center, Georgetown University and Dana-Farber Cancer Institute to permit us to use patents and patent applications. Termination of these rights or the failure to comply with obligations under these agreements could materially harm our business and prevent us from developing or commercializing our product candidates.
- The results of clinical trials may not support our product candidate claims.
- We may fail to enroll a sufficient number of patients in our clinical trials in a timely manner, which could delay or prevent clinical trials of our product candidates.
- If the commercial opportunity for mavorixafor in chronic neutropenic disorders, including WHIM syndrome, is smaller than we anticipate, our potential future revenue from mavorixafor for the treatment of any of the diseases may be adversely affected and our business may suffer.
- Interim top-line and preliminary data from our clinical trials that we announce or publish from time to time may change as more patient data become available and are subject to audit and verification procedures that could result in material changes in the final data.
- A breakthrough therapy designation or Fast Track designation by the FDA for our product candidates may not lead to a faster development or regulatory review or approval process, and neither of these designations increases the likelihood that our product candidates will receive marketing approval.

- Product candidates may cause undesirable side effects that could delay or prevent their marketing approval, limit the commercial profile of an approved label, or result in significant negative consequences following marketing approval, if any, including marketing withdrawal.
- If, in the future, we are unable to establish sales and marketing capabilities or to selectively enter into agreements with third parties to sell and market our product candidates, we may not be successful in commercializing our product candidates if and when they are approved.
- We face substantial competition that may result in others discovering, developing or commercializing products before or more successfully than we do.
- Even if we obtain and maintain approval for our product candidates from the FDA, we may never obtain approval for our product candidates outside of the United States, which would limit our market opportunities and could harm our business.
- Even if we are able to commercialize mavorixafor or any other product candidate that we develop, the product may become subject to unfavorable pricing regulations, third-party reimbursement practices or healthcare reform initiatives, which would harm our business.
- We have no experience manufacturing our product candidates on a large clinical or commercial scale and have no manufacturing facility. We are currently dependent on a single third party manufacturer for the manufacture of mavorixafor, the active pharmaceutical ingredient (“API”) and a single manufacturer of mavorixafor finished drug product capsules. If we experience problems with these third parties, the manufacturing of mavorixafor could be delayed, which could harm our results of operations.
- We rely on third-party CROs to conduct our preclinical studies and clinical trials. If these CROs do not successfully carry out their contractual duties or meet expected deadlines, we may not be able to obtain regulatory approval for or commercialize our product candidates and our business could be substantially harmed.
- Disruptions in our supply chain could delay the commercial launch of our product candidates.
- Our employees, principal investigators, CROs and consultants may engage in misconduct or other improper activities, including noncompliance with regulatory standards and requirements, which could have a material adverse effect on our business.
- We may depend on such collaborations for the development and commercialization of our product candidates. If those collaborations are not successful, we may not be able to capitalize on the market potential of our product candidates.
- If we are unable to protect our intellectual property rights, our competitive position could be harmed.
- Third parties may initiate legal proceedings alleging that we are infringing their intellectual property rights, the outcome of which would be uncertain and could have a material adverse effect on the success of our business.
- Our future success depends on our ability to retain executives and to attract, retain and motivate key personnel in a competitive environment for skilled biotechnology personnel.
- We will need to grow the size of our organization, and we may experience difficulties in managing this growth.
- Our term load contains restrictions that limit our flexibility in operating our business.
- Our business could be adversely affected by economic downturns, inflation, increases in interest rates, natural disasters, public health crises such as the COVID-19 pandemic, political crises, geopolitical events, such as the war in Ukraine, or other macroeconomic conditions, which have in the past and may in the future negatively impact our business and financial performance.
- Our stock price has been and is likely to continue to be volatile and fluctuate substantially.

Risks Related to Our Financial Position and Need for Additional Capital

We have incurred significant losses and have not generated revenue from product sales since our inception. We expect to continue to incur losses for the foreseeable future and we may never achieve or maintain profitability.

We are a late clinical-stage biopharmaceutical company. Investment in biopharmaceutical product development is highly speculative because it entails substantial upfront capital expenditures and significant risk that any potential product candidate will fail to demonstrate adequate effect or an acceptable safety profile, gain regulatory approval or become commercially viable. Since inception, we have incurred significant operating losses. Our net losses were \$93.9 million, \$88.7 million and \$62.1 million for the years ended December 31, 2022, 2021 and 2020 respectively, and we had an accumulated deficit of \$376.7 million as of December 31, 2022. We have funded our operations to date primarily with proceeds from sales of common stock, warrants and prefunded warrants for the purchase of our preferred stock and our common stock, sales of preferred stock, proceeds from the issuance of convertible debt and borrowings under loan and security agreements. We have no products approved for commercial sale and have not generated any revenue from product sales to date, and we may never generate product revenue or achieve profitability.

We expect to continue to incur significant expenses and increasing operating losses for at least the next several years as we conduct additional clinical trials for our product candidates; continue to discover and develop additional product candidates; acquire or in-license other product candidates and technologies; maintain, expand and protect our intellectual property portfolio; hire additional clinical, scientific and commercial personnel; establish a commercial manufacturing source and secure supply chain capacity sufficient to provide commercial quantities of any product candidates for which we may obtain regulatory approval; seek regulatory approvals for any product candidates that successfully complete clinical trials; establish a sales, marketing and distribution infrastructure to commercialize any products for which we may obtain regulatory approval; and add operational, financial and management information systems and personnel, including personnel to support our product development and planned future commercialization efforts. We may encounter unforeseen expenses, difficulties, complications, delays and other unknown factors that may adversely affect our business. The size of our future net losses will depend, in part, on the rate of future growth of our expenses and our ability to generate revenues.

Our ability to generate profits from operations and thereafter to remain profitable depends heavily on:

- the scope, number, progress, duration, endpoints, cost, results and timing of clinical trials and nonclinical studies of our current or potential future product candidates, including in particular the scope, progress, duration, endpoints, cost, results and timing for completion of our Phase 2 clinical trial of mavorixafor for the treatment of chronic neutropenic disorders;
- our ability to raise sufficient funds to support the development and potential commercialization of our product candidates;
- the outcomes and timing of regulatory reviews, approvals or other actions;
- our ability to obtain marketing approval for our product candidates;
- our ability to establish and maintain licensing, collaboration or similar arrangements on favorable terms and whether and to what extent we retain development or commercialization responsibilities under any new licensing, collaboration or similar arrangement;
- the success of any other business, product or technology that we acquire or in which we invest;
- our ability to maintain, expand and defend the scope of our intellectual property portfolio;
- our ability to manufacture any approved products on commercially reasonable terms;
- our ability to establish a sales and marketing organization or suitable third-party alternatives for any approved product;
- the number and characteristics of product candidates and programs that we pursue;
- hire additional clinical, regulatory and scientific personnel; and
- incur additional legal, accounting and other expenses associated with operating as a public company.

Based on our current plans, we do not expect to generate significant revenue from product sales unless and until we (or a potential future licensee or collaborator) obtain marketing approval for, and commercialize, one or more of our current or potential future product candidates. Neither we nor a licensee may ever succeed in obtaining marketing approval for, or commercializing, our product candidates and, even if we do, we may never generate revenues that are significant enough to generate profits from operations. Even if we do generate profits from operations, we may not be able to sustain or increase profitability on a quarterly or annual basis. Our failure to generate profits from operations and remain profitable would decrease our value and could impair our ability to raise capital, expand our business, maintain our research and development efforts, diversify our product offerings or continue our operations. A decline in our value could also cause you to lose all or part of your investment.

We may encounter unforeseen expenses, difficulties, complications, delays and other known and unknown factors that may alter or delay our plans. For example, we experienced delays in clinical trial site activation and slower patient enrollment in some of our clinical trials as a result of the COVID-19 pandemic, which delayed our expectations regarding our ability to report data from those trials, and we may encounter additional delays, disruptions and other direct and indirect negative effects of the ongoing COVID-19 pandemic on our clinical trials. Assuming that we complete the development of and obtain marketing approval for any of our product candidates, we will need to transition from a company with a research and development focus to a company capable of supporting commercial activities. We may encounter unforeseen expenses, difficulties, complications and delays, and may not be successful in such a transition.

Our liquidity position raises substantial doubt about our ability to continue as a going concern and we will require substantial additional funding. If we are unable to raise capital when needed, we could be forced to delay, reduce or eliminate any product development programs or commercialization efforts.

We may be forced to delay or reduce the scope of our development programs and/or limit or cease our operations if we are unable to obtain additional funding to support our current operating plan. We have identified conditions and events that raise substantial doubt about our ability to continue as a going concern.

Our operations have consumed a large amount of cash since inception. To date, we have funded our operations primarily with proceeds from sales of common stock, warrants and prefunded warrants for the purchase of our preferred stock and our common stock, sales of preferred stock, proceeds from the issuance of convertible debt and borrowings under loan and security agreements. We expect our research and development expenses to increase in future periods as we continue to advance the clinical development of our product candidates and prepare for the launch and commercialization of any product candidates for which we receive regulatory approval, including potentially building our own commercial organization to address the U.S. and certain other markets. In addition, if we obtain marketing approval for any of our product candidates that are not then subject to licensing, collaboration or similar arrangements with third parties, we expect to incur significant commercialization expenses related to product sales, marketing, distribution and manufacturing. Furthermore, we expect to incur additional costs associated with operating as a public company.

As of December 31, 2022, we have cash and cash equivalents of \$121.7 million. We will require additional capital to sustain our operations, and to carry out our business plans, which may include raising funds through public or private equity or debt financings, third-party funding, marketing and distribution arrangements, as well as other collaborations, strategic alliances and licensing arrangements, or any combination of these approaches. While we have successfully raised capital in the past, our ability to raise capital in future periods is not assured. We will also require additional capital to satisfy the covenant under our existing debt facility with Hercules Capital, Inc. and certain affiliated entities (“Hercules”) that requires that we maintain a minimum level of cash of \$20.0 million, subject to reduction to \$10.0 million upon the achievement of certain conditions. Based on our current cash flow projections and assuming no additional funding, we will fail to maintain the minimum cash required to satisfy this covenant as soon as the first quarter of 2024. In such event, Hercules could require the repayment of all outstanding debt. Based on the foregoing, we have concluded that substantial doubt exists about our ability to continue as a going concern for a period of at least 12 months from the date of issuance of the financial statements appearing elsewhere in this Annual Report. Our financial statements have been prepared assuming that we will continue as a going concern, which contemplates the realization of assets and the settlement of liabilities and commitments in the normal course of business. The financial statements do not include any adjustments relating to the recoverability and classification of recorded asset amounts or the amounts and classification of liabilities that might result from the outcome of the uncertainty described above. See also the risk factor titled “*Our term loan contains restrictions that limit our flexibility in operating our business*” below.

We cannot be certain that additional funding will be available on acceptable terms, or at all. If we are unable to raise additional capital when needed or in sufficient amounts or on terms acceptable to us, we could be forced to delay, reduce or eliminate our research and development programs or any future commercialization efforts of one or more of our product candidates or one or more of our other research and development initiatives. In addition, when we need to secure additional financing, such additional fundraising efforts may divert our management from our day-to-day activities, which may adversely affect our ability to develop and commercialize our product candidates. Any of these events could significantly harm our business, financial condition and prospects, and our stockholders could lose all or part of their investment in our company.

We also could be required to:

- seek new or additional collaborators for one or more of our current or future product candidates at an earlier stage than otherwise would be desirable or on terms that are less favorable than might otherwise be available; or
- relinquish or license on unfavorable terms our rights to technologies or product candidates that we otherwise would seek to develop or commercialize ourselves.

Our future funding requirements, both near and long-term, will depend on many factors, including, but not limited to:

- the scope, number, initiation, progress, timing, costs, design, duration, any potential delays, and results of clinical trials and nonclinical studies for our current or future product candidates;
- the clinical development plans that we establish for these product candidates;
- the number and characteristics of product candidates and programs that we develop or may in-license;
- the outcome, timing and cost of regulatory reviews, approvals or other actions to meet regulatory requirements established by the U.S. Food and Drug Administration (“FDA”) and comparable foreign regulatory authorities, including the potential for the FDA or comparable foreign regulatory authorities to require that we perform more studies for our product candidates than those that we currently expect;
- our ability to obtain marketing approval for our product candidates;
- the cost of filing, prosecuting, defending and enforcing our patent claims and other intellectual property rights covering our product candidates, including any such patent claims and intellectual property rights that we have licensed from Genzyme pursuant to the terms of our license agreement with Genzyme or from other third parties;
- our ability to maintain, expand and defend the scope of our intellectual property portfolio, including the cost of defending intellectual property disputes, including patent infringement actions brought by third parties against us or our product candidates;
- the cost and timing of completion of commercial-scale manufacturing activities with respect to our product candidates;
- our ability to establish and maintain licensing, collaboration or similar arrangements on favorable terms and whether and to what extent we retain development or commercialization responsibilities under any new licensing, collaboration or similar arrangement;
- the cost of establishing sales, marketing and distribution capabilities for any product candidates for which we may receive regulatory approval in regions where we choose to commercialize our products on our own;
- the success of any other business, product or technology that we acquire or in which we invest;
- the costs of acquiring, licensing or investing in businesses, product candidates and technologies;
- our need and ability to hire additional management and scientific and medical personnel;
- market acceptance of our product candidates, to the extent any are approved for commercial sale;
- the effect of competing technological and market developments;
- the costs to operate as a public company; and

- business interruptions resulting from pandemics and public health emergencies, including those related to the ongoing COVID-19 pandemic, geopolitical actions, including war and terrorism or natural disasters including earthquakes, typhoons, floods and fires.

Raising additional capital may cause dilution to our investors, restrict our operations or require us to relinquish rights to our technologies or product candidates. Future debt obligations may expose us to risks that could adversely affect our business, operating results and financial condition and may result in further dilution to our stockholders.

Until such time, if ever, as we can generate substantial product revenues, we expect to finance our cash needs through public or private equity or debt financings, third-party funding, marketing and distribution arrangements, as well as other collaborations, strategic alliances and licensing arrangements, or any combination of these approaches. Other than our common stock purchase agreement with Lincoln Park Capital Fund LLC (“Lincoln Park”), pursuant to which Lincoln Park is obligated, subject to certain limitations and conditions, to purchase up to \$50.0 million in the aggregate of shares of our common stock, we do not have any committed external sources of funds and may seek to raise additional capital at any time. To the extent that we raise additional capital through the sale of equity or convertible debt securities, your ownership interest will be diluted, and the terms of these securities may include liquidation or other preferences that adversely affect your rights as a holder of our common stock. Debt financing, if available, may involve agreements that include covenants limiting or restricting our ability to take specific actions, such as incurring additional debt, making capital expenditures, declaring dividends or other distributions, acquiring or licensing intellectual property rights and other operating restrictions that could adversely impact our ability to conduct our business and may result in liens being placed on additional assets such as intellectual property. For example, our debt facility with Hercules contains a minimum cash financial covenant that we project we would be in violation of in the first quarter of 2024 based on our current cash flow projections, assuming we do not raise additional funding. If we default on such indebtedness, with Hercules or a future lender, we could be required to pledge additional assets, or the lenders could enforce remedies on the current collateral.

If we raise additional funds through licensing, collaboration or similar arrangements with third parties, we may have to relinquish valuable rights to our technologies, future revenue streams, research and development programs or product candidates or grant licenses on terms that are not favorable to us. If we are unable to raise additional funds through equity or debt financings or through licensing, collaboration or similar arrangements when needed, we may be required to delay, limit, reduce or terminate our product development or future commercialization efforts or grant rights to develop and market product candidates that we would otherwise prefer to develop and market ourselves.

We have not generated revenues from any product sales since inception and may never become profitable.

To date, we have not generated revenues from any product sales. Our ability to generate revenue and become profitable depends upon our ability to successfully obtain marketing approval and commercialize our product candidates, including mavorixafor, or other product candidates that we may develop, in-license or acquire in the future. Even if we are able to successfully achieve regulatory approval for these product candidates, we are unable to predict the extent of any future losses and do not know when any of these product candidates will generate revenue for us, if at all. Our ability to generate revenue from mavorixafor or any of our current or future product candidates also depends on a number of additional factors, including our ability to:

- successfully complete development activities, including all necessary nonclinical studies and clinical trials;
- complete and submit New Drug Applications to the FDA and obtain regulatory approval for indications for which there is a commercial market;
- complete and submit marketing applications to, and obtain regulatory approval from, foreign regulatory authorities;
- set and obtain a commercially viable price for our products;
- obtain commercial quantities of our products at acceptable cost levels;
- develop a commercial organization capable of sales, marketing and distribution for the products we intend to sell ourselves in the markets in which we have retained commercialization rights;
- find suitable collaborators to help us market, sell and distribute our approved products in other markets; and
- obtain coverage and adequate reimbursement from third-party, including government, payors.

In addition, because of the numerous risks and uncertainties associated with product development, including the possibility that our product candidates may not advance through development or demonstrate safety and efficacy for their intended uses, the FDA or any other regulatory agency may require additional clinical trials or nonclinical studies. We are unable to predict the timing or amount of increased expenses, or when or if we will be able to achieve or maintain profitability, and such expense could increase beyond our expectations if the FDA or any other regulatory agency requires such additional clinical trials or nonclinical studies as part of the application and approval process or post-approval process if we are successful at achieving regulatory approval. Even if we are able to successfully complete the development and regulatory reviews described above, we anticipate incurring significant costs associated with commercializing these products, if they are approved.

Even if we are able to generate revenues from the sale of our product candidates, we may not become profitable and may need to obtain additional funding to continue operations. If we fail to become profitable or are unable to sustain profitability on a continuing basis, then we may be unable to continue our operations at planned levels and be forced to reduce our operations. If we do achieve profitability, we may not be able to sustain or increase profitability on a quarterly or annual basis. Our failure to become and remain profitable would decrease the value of the company and could impair our ability to raise capital, maintain our discovery and preclinical development efforts, expand our business or continue our operations and may require us to raise additional capital that may dilute your ownership interest. A decline in our value could also cause you to lose all or part of your investment.

Changes in estimates regarding fair value of intangible assets may result in an adverse impact on our results of operations.

We test goodwill for impairment annually or more frequently if changes in circumstances or the occurrence of events suggest impairment exists. Any significant change in market conditions, including a sustained decline in our stock price, that indicate a reduction in carrying value may give rise to impairment in the period that the change becomes known. For example, as of December 31, 2021, our market capitalization, measured as the price of our common stock multiplied by shares of common stock outstanding, declined to below the value of our net assets, including goodwill. As a result of the sustained decline in the market price of our common stock, the fair value of our single reporting unit, measured based on our market capitalization as of December 31, 2021, was lower than its carrying value and we concluded that goodwill was impaired. Accordingly, we recorded an impairment charge of \$9.8 million to reduce the carrying amount of goodwill to \$17.4 million as of December 31, 2021. While we determined that goodwill was not impaired based on its quantitative test as of December 31, 2022, future declines in the market value of our common stock may result in additional impairment charges being recorded.

Risks Related to Development of Our Product Candidates

We depend almost entirely on the success of our lead product candidate, mavoxixafor, which we are developing for the potential treatment of chronic neutropenic disorders, including WHIM syndrome, and, contingent on a potential strategic partnership, for the treatment of Waldenström's. We cannot be certain that we will be able to obtain regulatory approval for, or successfully commercialize, mavoxixafor or any other product candidate.

Our business depends almost entirely on the successful clinical development, regulatory approval and commercialization of mavoxixafor. We currently have no products for sale and may never be able to develop marketable drug products. The clinical trials of our product candidates are, and the manufacturing and marketing of our product candidates will be, subject to extensive and rigorous review and regulation by government authorities in the United States and in other countries where we intend to test and, if approved, market any product candidate. Before obtaining regulatory approvals for the commercial sale of any product candidate, we must successfully meet a number of critical developmental milestones, including:

- developing dosages that will be well-tolerated, safe and effective;
- completing the development and scale-up to permit manufacture of our product candidates in commercial quantities and at acceptable costs;
- demonstrating through pivotal clinical trials that each product candidate is safe and effective in patients for the intended indication;
- establishing commercial manufacturing capabilities or making arrangements with third-party manufacturers; and
- obtaining and maintaining patent and trade secret protection and non-patent exclusivity for our product candidates.

The time necessary to achieve these developmental milestones for any individual product candidate is long and uncertain, and we may not successfully complete these milestones for mavorixafor or any other product candidates that we may develop. We have not yet completed development of any product candidate. We also may not be able to finalize the design or formulation for our other programs. We may not be able to complete development of any product candidates that demonstrate safety and efficacy and that will have a commercially reasonable treatment and storage period. If we are unable to complete development of mavorixafor or any other product candidates that we may develop, we will not be able to commercialize and earn revenue from them.

We may develop mavorixafor, and potentially future product candidates, in combination with other therapies, which could expose us to additional risks.

We may develop mavorixafor, and may develop future product candidates, in combination with one or more currently approved therapies. Even if any product candidate we develop were to receive marketing approval or be commercialized for use in combination with other existing therapies, we would continue to be subject to the risks that the FDA or similar regulatory authorities outside of the United States could revoke approval of the therapy used in combination with our product candidate or that safety, efficacy, manufacturing or supply issues could arise with these existing therapies. Combination therapies are commonly used for the treatment of diseases, and we would be subject to similar risks if we develop any of our product candidates for use in combination with other drugs. This could result in our own products being removed from the market or being less successful commercially.

We may also evaluate mavorixafor or any other future product candidates in combination with one or more other cancer therapies that have not yet been approved for marketing by the FDA or similar regulatory authorities outside of the United States. We will not be able to market and sell mavorixafor or any product candidate we develop in combination with any such unapproved therapies that do not ultimately obtain marketing approval.

If the FDA or similar regulatory authorities outside of the United States do not approve these other drugs or revoke their approval of, or if safety, efficacy, manufacturing or supply issues arise with, the drugs that we choose to evaluate in combination with mavorixafor or any product candidate we develop, we may be unable to obtain approval of or market mavorixafor or any product candidate we develop.

The regulatory review and approval processes of the FDA and comparable foreign regulatory authorities are lengthy, time-consuming and inherently unpredictable, and if we are ultimately unable to obtain regulatory approval for our product candidates, including mavorixafor, our business will be substantially harmed.

We are not permitted to market mavorixafor or any other product candidate in the United States until we receive approval of a New Drug Application (“NDA”) from the FDA, or in any foreign countries until we receive the requisite approval from such countries or jurisdictions, such as the marketing authorization application (“MAA”) in the European Union from the European Medicines Agency (“EMA”). Prior to submitting an NDA to the FDA for approval of mavorixafor for the treatment of WHIM syndrome, we will need to complete the analysis of the data collected in our Phase 3 pivotal clinical trial of mavorixafor in patients with WHIM syndrome. Our NDA submission may receive a refusal to file response from the FDA, and even if filed by the FDA, we may receive a Complete Response Letter rather than approval for commercial marketing. In addition, we may be required by the FDA to conduct additional clinical trials and/or nonclinical studies to support potential approval. Successfully completing clinical trials and obtaining approval of an NDA is a complex, lengthy, expensive and uncertain process, and the FDA, or a comparable foreign regulatory authority, may delay, limit or deny approval of mavorixafor for the treatment of WHIM syndrome or other indications for many reasons, including, among others:

- disagreement with the design or implementation of our clinical trials;
- disagreement with the sufficiency of our clinical trials;
- failure to demonstrate the safety and efficacy of mavorixafor or any other product candidate for its proposed indications;
- failure to demonstrate that any clinical and other benefits of mavorixafor or any other product candidate outweigh its safety risks;
- a negative interpretation of the data from our nonclinical studies or clinical trials;
- deficiencies in the manufacturing or control processes or failure of third-party manufacturing facilities with which we contract for clinical and commercial supplies to comply with current Good Manufacturing Practice requirements, or cGMPs;

- insufficient data collected from clinical trials of mavorixafor or changes in the approval requirements that render its nonclinical and clinical data insufficient to support the filing of an NDA or to obtain regulatory approval; or
- changes in clinical practice in or approved products available for the treatment of the target patient population that could have an impact on the indications that we are pursuing for mavorixafor or our other product candidates.

The FDA or a comparable foreign regulatory authority may also require more information, including additional nonclinical or clinical data to support approval, which may delay or prevent approval of our commercialization plans, or cause us to abandon the development program. Even if we obtain regulatory approval, our product candidates may be approved for fewer or more limited indications than we request, such approval may be contingent on the performance of costly post-marketing clinical trials, or we may not be allowed to include the labeling claims necessary or desirable for the successful commercialization of such product candidate. For instance, it is possible that mavorixafor could be approved for an indication but fail to be used for treating patients in that indication due to the availability of other available treatments or then-accepted clinical practice.

We depend on license agreements with Genzyme, Beth Israel Deaconess Medical Center, Georgetown University and Dana-Farber Cancer Institute to permit us to use patents and patent applications. Termination of these rights or the failure to comply with obligations under these agreements could materially harm our business and prevent us from developing or commercializing our product candidates.

We are party to license agreements with Genzyme, Beth Israel Deaconess Medical Center, Georgetown University and Dana-Farber Cancer Institute under which we were granted rights to patents and patent applications that are important to our business. We rely on these license agreements in order to be able to use various proprietary technologies that are material to our business, including certain patents and patent applications that cover our product candidates, including mavorixafor. Our rights to use these patents and patent applications and employ the inventions claimed in these licensed patents are subject to the continuation of and our compliance with the terms of our license agreements.

Our license agreement with Genzyme imposes upon us various diligence, payment and other obligations, including the following:

- our obligation to pay Genzyme milestone payments in the aggregate amount of up to \$25.0 million, contingent upon our achievement of certain late-stage regulatory and sales milestones with respect to licensed products.
- our obligation to pay Genzyme tiered royalties based on net sales of licensed products that we commercialize under the agreement.
- our obligation to pay Genzyme a certain percentage of cash payments received by us or our affiliates in consideration for the grant of a sublicense under the license granted to us by Genzyme.

If we fail to comply with any of our obligations under the Genzyme license agreement, or we are subject to a bankruptcy, Genzyme may have the right to terminate the license agreement, in which event we would not be able to market any product candidates covered by the license.

Prior to July 2014, we did not control the prosecution, maintenance, or filing of the patents and patent applications that are licensed to us under the Genzyme license agreement, or the enforcement of these patents and patent applications against infringement by third parties. Thus, these patents and patent applications were not drafted by us or our attorneys, and we did not control or have any input into the prosecution of these patents and patent applications prior to our execution of the Genzyme license agreement in July 2014. Under the terms of the license agreement with Genzyme, since July 2014, we have controlled the right to control the prosecution, maintenance, and filing of the patents and patent applications that are licensed to us, and the enforcement of these patents and patent applications against infringement by third parties. However, we cannot be certain that the same level of attention was given to the drafting and prosecution of these patents and patent applications as we may have used if we had control over the drafting and prosecution of such patents and patent applications. We also cannot be certain that drafting or prosecution of the patents and patent applications licensed to us has been conducted in compliance with applicable laws and regulations or will result in valid and enforceable patents.

Pursuant to our license agreement with Beth Israel Deaconess Medical Center, we paid an upfront, one-time fee for the rights granted by the license agreement. This license agreement imposes upon us various obligations, including the requirement to provide Beth Israel Deaconess Medical Center with progress reports at regular intervals and to maintain specified levels of insurance. Beth Israel Deaconess Medical Center may terminate the agreement for our non-payment, insolvency or default of material obligations. We have the right to terminate the agreement for any reason upon 90 days' advance written notice.

Our license agreement with Georgetown imposes upon us various diligence, payment and other obligations, including our obligations to pay Georgetown milestone payments in the aggregate amount of up to \$0.8 million, contingent upon our achievement of certain sales milestones with respect to licensed products, to deliver reports upon certain events and at regular intervals and to maintain customary levels of insurance. Georgetown may terminate the agreement for our non-payment, insolvency, failure to maintain insurance or default of material obligations. We have the right to terminate the agreement for any reason upon 60 days advance written notice.

Our license agreement with the Dana-Farber Cancer Institute ("DFCI") imposes upon us various diligence, payment and other obligations, including our obligations to pay DFCI milestone payments in the aggregate amount of up to approximately \$32 million, contingent upon our achievement of certain regulatory and sales milestones with respect to licensed products, to deliver reports at regular intervals and to maintain certain minimum levels of insurance. DFCI may terminate the agreement if (i) we cease to carry on our business with respect to the licensed products, (ii) we default on diligence, insurance, payment or any other material obligations, (iii) one of our officers or that of a sublicensee is convicted of a felony relating to the manufacture, use, sale or importation of one or more licensed product, (iv) we become insolvent, (v) we grant a sublicense without notifying DFCI or on terms inconsistent with the terms required of sublicenses under the agreement or (vi) we bring a patent challenge against the licensed products. We have the right to terminate the agreement for any reason upon 90 days advance written notice.

Disputes may arise under any of our license agreements with Genzyme, Beth Israel Deaconess Medical Center, Georgetown University and/or Dana-Farber Cancer Institute regarding the intellectual property that is subject to such license agreement, including:

- the scope of rights granted under the applicable license agreement and other interpretation-related issues;
- whether and the extent to which our technology and processes infringe on intellectual property that is not subject to the applicable license agreement;
- our diligence obligations with respect to the use of the licensed technology under the applicable license agreement to develop and commercialize products and technologies, including the level of effort and specific activities that will satisfy those diligence obligations; and
- the ownership of inventions and know-how resulting from the joint creation or use of intellectual property by us and our collaborators.

If disputes over intellectual property that we have licensed prevent or impair our ability to maintain any of our license agreements on acceptable terms, we may be unable to successfully develop and commercialize the affected product candidates and technologies.

The results of clinical trials may not support our product candidate claims.

Even if our clinical trials are completed as planned, we cannot be certain that their results will support the proposed product candidates, that the FDA or foreign government authorities will agree with our conclusions regarding such results, or that the FDA or foreign governmental authorities will not require additional clinical trials. Success in preclinical testing and early clinical trials does not ensure that later clinical trials will be successful and the results of later clinical trials often do not replicate the results of prior clinical trials and preclinical testing. The clinical trial results may fail to demonstrate that our product candidates are safe for humans and effective for the intended indications. This failure could cause us to abandon a product candidate and may delay development of other product candidates. Any delay in, or termination of, our clinical trials will delay or prevent the submission of our marketing applications (NDA and/or MAA) and, ultimately, our ability to obtain approval and commercialize our product candidates and generate product revenues. Information about certain clinical trials, including results (positive or negative) will be made public according to each country's clinical trial register policies. Competitors may use this publicly available information to gain knowledge regarding the progress of development programs.

Delays in our clinical trials may lead to a delay in the submission of our marketing approval application and jeopardize our ability to potentially receive approvals and generate revenues from the sale of our products.

We may experience delays in our current or future clinical trials, including our Phase 2 clinical trial of mavorixafor for the treatment of chronic neutropenic disorders. As a result of the ongoing COVID-19 pandemic, we experienced delays in clinical trial site activation and slower patient enrollment in our clinical trials of mavorixafor for the treatment of WHIM syndrome, Waldenström's and chronic neutropenia disorders. Clinical trials may be delayed, suspended or terminated for a variety of reasons, including the following:

- delay or failure in reaching agreement with the FDA or a comparable foreign regulatory authority on a trial design that we are able to execute;
- delay or failure in obtaining authorization to commence a trial or inability to comply with conditions imposed by a regulatory authority regarding the scope or design of a clinical trial;
- inability, delay or failure in identifying and maintaining a sufficient number of trial sites, many of which may already be engaged in competing clinical trial programs;
- delay or failure in recruiting and enrolling suitable subjects to participate in a trial;
- delay or failure in having subjects complete a trial or return for post-treatment follow-up;
- clinical sites and investigators deviating from trial protocol, failing to conduct the trial in accordance with regulatory requirements, or dropping out of a trial;
- delay or failure in reaching agreement on acceptable terms with prospective clinical research organizations ("CROs") and clinical trial sites, the terms of which can be subject to extensive negotiation and may vary significantly among different CROs and trial sites;
- delay or failure in obtaining institutional review board ("IRB") approval to conduct a clinical trial at each site;
- delays resulting from negative or equivocal findings of the Data Safety Monitoring Board ("DSMB") if any;
- ambiguous or negative results;
- decision by the FDA, a comparable foreign regulatory authority, or recommendation by a DSMB to suspend or terminate clinical trials at any time for safety issues or for any other reason;
- inadequate drug product for use in nonclinical studies or clinical trials;
- lack of adequate funding to continue the product development program;
- external business disruptions affecting the initiation, patient enrollment, development and operation of our clinical trials, including a public health emergency, such as the COVID-19 pandemic, and unforeseen events such as the war in Ukraine; or
- changes in governmental regulations or requirements.

Any delays in completing our clinical trials will increase our costs, slow down our product candidate development and approval process and jeopardize our ability to commence product sales and generate revenues. Any of these occurrences may significantly harm our business, financial condition and prospects. In addition, many of the factors that cause, or lead to, a delay in the commencement or completion of clinical trials may also ultimately lead to the denial of regulatory approval of our product candidates.

We may fail to enroll a sufficient number of patients in our clinical trials in a timely manner, which could delay or prevent clinical trials of our product candidates.

Identifying and qualifying patients to participate in clinical trials of our product candidates is critical to our success. The timing of our clinical trials depends on the rate at which we can recruit, enroll and retain patients in testing our product candidates, and we have made certain assumptions about the rate at which we can enroll patients in our clinical trials. The timing of our clinical trials depends in part on the speed at which we can recruit patients to participate in testing mavorixafor and any other current or future product candidates that we may develop as well as completion of required follow-up periods. For example, as a result of the ongoing COVID-19 pandemic, we have experienced, and expect to continue to experience, a slower enrollment pace.

If we cannot identify patients to participate in our clinical trials or if patients are unwilling to participate in our clinical trials for any reason, including if patients choose to enroll in competitive clinical trials for similar patient populations, the timeline for recruiting patients, conducting studies and obtaining regulatory approval of mavorixafor and any other current or future product candidates that we may develop may be delayed. These delays could result in increased costs, delays in advancing our current or future product candidates, delays in testing the effectiveness of our product candidates or termination of the clinical trials altogether.

We may not be able to identify, recruit and enroll a sufficient number of patients, or those with required or desired characteristics to achieve diversity in a trial, to complete our current and future clinical trials in a timely manner. In particular, we are currently evaluating mavorixafor for the treatment of WHIM syndrome and chronic neutropenic disorders, rare diseases with limited patient pools from which to draw for clinical trials. The eligibility criteria of our clinical trials will further limit the pool of available trial participants. If we experience difficulty enrolling a sufficient number of patients to conduct our clinical trials as planned, we may be forced to delay, limit or terminate ongoing or planned clinical trials of our product candidates, which would delay our ability to obtain approvals and generate product revenues from any of these product candidates.

If the commercial opportunity for mavorixafor in chronic neutropenic disorders, including WHIM syndrome, is smaller than we anticipate, our potential future revenue from mavorixafor for the treatment of any of the diseases may be adversely affected and our business may suffer.

If the size of the commercial opportunities in any of our target indications is smaller than we anticipate, we may not be able to achieve profitability and growth. Our lead clinical candidate, mavorixafor, is being developed as an oral, once-daily therapy for the potential treatment of a variety of chronic neutropenic disorders, including WHIM syndrome. We have advanced mavorixafor through a pivotal, Phase 3 clinical trial (the “4WHIM trial”) in people with WHIM syndrome, and are currently advancing mavorixafor in a Phase 2 clinical trial in people with certain chronic neutropenic disorders. We are currently aware of only a few small available patient registries for WHIM syndrome, and we rely on various estimates and assumptions to estimate the addressable WHIM syndrome population. Based on a broad online survey of physicians to validate current prevalence estimates and additional research using artificial intelligence, which interrogated a database of more than 300 million anonymized patient records that spanned 10 years of insurance claims, we estimate there are up to 3,700 diagnosed and undiagnosed WHIM patients in the United States, many of whom were previously undiagnosed. If the commercial opportunity in any of our target indications, including WHIM syndrome is smaller than we anticipate, whether because our estimates of the addressable patient population prove to be incorrect or for other reasons, our potential future revenue from mavorixafor may be adversely affected and our business may suffer.

It is critical to our ability to grow and become profitable that we successfully identify patients with WHIM syndrome and other chronic neutropenic disorders. Our projections of the number of people who have WHIM syndrome (or its other potential primary immunodeficiencies) and chronic neutropenic disorders are based on a variety of sources, including third-party estimates and analyses in the scientific literature, and may prove to be incorrect. Further, new information may emerge that changes our estimate of the prevalence of these diseases or the number of patient candidates for each disease. The effort to identify patients for treatment is at an early stage, and we cannot accurately predict the number of patients for whom treatment might be possible. Additionally, the addressable patient population for our indications may be limited or may not be amenable to treatment with mavorixafor, and new patients may become increasingly difficult to identify or gain access to, which would adversely affect our results of operations and our business.

Results of earlier clinical trials may not be predictive of the results of later-stage clinical trials.

The results of pre-clinical studies and early clinical trials of our product candidates may not be predictive of the results of later-stage clinical trials. Interpretation of results from early, usually smaller, trials that suggest positive trends in some subjects, require caution. Results from later stages of clinical trials enrolling more subjects may fail to show the desired safety and efficacy results or otherwise fail to be consistent with the results of earlier trials of the same product candidate. Inconsistencies may occur for a variety of reasons, including differences in trial design, trial endpoints (or lack of trial endpoints in exploratory studies), subject population, number of subjects, subject selection criteria, trial duration, drug dosage and formulation or due to the lack of statistical power in the earlier trials.

Data obtained from preclinical and clinical activities are subject to varying interpretations, which may delay, limit, or prevent regulatory approval. In addition, we may experience regulatory delays or rejections as a result of many factors, including due to changes in regulatory policy during the period of our product candidate development. Any such delays could negatively impact our business, financial condition, results of operations and prospects.

Interim top-line and preliminary data from our clinical trials that we announce or publish from time to time may change as more patient data become available and are subject to audit and verification procedures that could result in material changes in the final data.

From time to time, we may publish interim top-line or preliminary data from our clinical trials. Interim data from clinical trials that we may complete are subject to the risk that one or more of the clinical outcomes may materially change as patient enrollment continues and more patient data become available. Preliminary or top-line data also remain subject to audit and verification procedures that may result in the final data being materially different from the preliminary data we previously published. Preliminary or top-line data may include, for example, data regarding a small percentage of the patients enrolled in a clinical trial, and such preliminary data should not be viewed as an indication, belief or guarantee that other patients enrolled in such clinical trial will achieve similar results or that the preliminary results from such patients will be maintained. As a result, interim and preliminary data should be viewed with caution until the final data are available. Differences between preliminary or interim data and final data could significantly harm our business prospects and may cause the trading price of our common stock to fluctuate significantly.

Risks Related to the Marketing and Commercialization of Our Product Candidates

Even if our product candidates receive regulatory approval, they may still face future development and regulatory difficulties and any approved products will be subject to extensive post-approval regulatory requirements.

If we obtain regulatory approval for a product candidate, it would be subject to extensive ongoing requirements by the FDA and comparable foreign regulatory authorities governing the manufacture, quality control, further development, labeling, packaging, storage, distribution, safety surveillance, import, export, advertising, promotion, recordkeeping and reporting of safety and other post-market information. The safety profile and efficacy of any product will continue to be closely monitored by the FDA and comparable foreign regulatory authorities after approval. If the FDA or comparable foreign regulatory authorities become aware of new safety information after approval of any of our product candidates, these regulatory authorities may require labeling changes or the FDA may require establishment of a Risk Evaluation Mitigation Strategy (“REMS”), or similar strategy, impose significant restrictions on a product’s indicated uses or marketing, impose ongoing requirements for potentially costly post-approval studies or post-market surveillance. Progress reports are required at quarterly intervals, every six months and at annual intervals depending upon the country, and more frequently if serious adverse events occur.

In addition, manufacturers of drugs and their facilities are subject to continual review and periodic inspections by the FDA and other regulatory authorities for compliance with cGMP regulations. If a regulatory agency discovers previously unknown problems with a product, such as adverse events of unanticipated severity or frequency, or problems with the facility where the product is manufactured, a regulatory agency may impose restrictions on that product, the manufacturing facility or us, including requiring recall or withdrawal of the product from the market or suspension of manufacturing. If we, our product candidates or the manufacturing facilities for our product candidates fail to comply with cGMPs and other applicable regulatory requirements, the FDA may, among other things:

- issue warning letters;
- request modifications to promotional materials or require us to provide corrective information to healthcare practitioners;
- require us to enter into a consent decree, which can include imposition of various fines, reimbursements for inspection costs, required due dates for specific actions and penalties for noncompliance;
- seek an injunction or impose civil or criminal penalties or monetary fines;
- suspend or withdraw regulatory approval;
- suspend any ongoing clinical trials;
- refuse to approve pending applications or supplements to applications filed by us;
- suspend or impose restrictions on operations, including costly new manufacturing requirements; or
- seize or detain products, refuse to permit the import or export of products, or require us to initiate a product recall.

The occurrence of any event or penalty described above may inhibit our ability to commercialize our products and generate revenue.

The FDA and other regulatory agencies actively enforce the laws and regulations prohibiting the promotion of off-label uses. If we are found or alleged to have improperly promoted off-label uses, we may become subject to significant liability.

The FDA and other regulatory agencies strictly regulate the promotional claims that may be made about drug products. These regulations include standards and restrictions for direct-to-consumer advertising, industry-sponsored scientific and educational activities, promotional activities involving the internet and off-label promotion. For example, any regulatory approval that the FDA grants is limited to those indications and patient populations for which a drug is deemed to be safe and effective by the FDA.

While physicians in the United States may choose, and are generally permitted, to prescribe products for uses that are not described in the product's labeling and for uses that differ from those tested in clinical trials and approved by the regulatory authorities, our ability to promote any of our products candidates, if approved, will be narrowly limited to those indications and populations that are specifically approved by the FDA or such other regulatory agencies, and if we are found to have promoted such off-label uses, we may become subject to significant liability. For example, the federal government has levied large civil and criminal fines against companies for alleged improper promotion and has enjoined several companies from engaging in off-label promotion. The government has also required companies to enter into consent decrees or imposed permanent injunctions under which specified promotional conduct is changed or curtailed. If we cannot successfully manage the promotion of our product candidates, if approved, we could become subject to significant liability, which would materially adversely affect our business and financial condition.

A breakthrough therapy designation or Fast Track designation by the FDA for our product candidates may not lead to a faster development or regulatory review or approval process, and neither of these designations increases the likelihood that our product candidates will receive marketing approval.

We have obtained both breakthrough therapy and Fast Track designations for mavorixafor for the treatment of adult patients with WHIM and we may pursue those designations for other product candidates as well. A breakthrough therapy is defined as a product that is intended, alone or in combination with one or more other drugs, to treat a serious or life-threatening condition, and preliminary clinical evidence indicates that the product may demonstrate substantial improvement over existing therapies on one or more clinically significant endpoints. For product candidates that have been designated as breakthrough therapies, interaction and communication between the FDA and the sponsor of the trial can help identify the most efficient path for clinical development while minimizing the number of patients placed in ineffective control regimens. A breakthrough therapy designation affords the possibility of rolling review, enabling the FDA to review portions of our marketing application before submission of a complete application, and possibly, priority review.

If a drug or biologic candidate is intended for the treatment of a serious or life-threatening condition or disease and the drug demonstrates the potential to address unmet medical needs for the condition, the sponsor may apply for Fast Track designation.

Designation as a breakthrough therapy and Fast Track designation are within the discretion of the FDA. Accordingly, even if we believe that our product candidates meet the criteria for designation as a breakthrough therapy or Fast Track designation, the FDA may disagree and instead determine not to make such designation. In any event, the receipt of either or both of a breakthrough therapy designation or Fast Track designation for a product candidate may not result in a faster development process, review or approval compared to products considered for approval under conventional FDA procedures and does not assure ultimate approval by the FDA. In addition, even if one or more of our product candidates qualify as breakthrough therapies or for Fast Track designation, the FDA may later decide that the products no longer meet the conditions for qualification.

It is possible that we may not be able to obtain or maintain orphan drug designation or exclusivity for our drug candidates, which could limit the potential profitability of our product candidates.

Regulatory authorities in some jurisdictions, including the United States and Europe, may designate drugs for the treatment or prevention of rare diseases or conditions with relatively small patient populations as orphan drugs. Under the Orphan Drug Act of 1983, the ("Orphan Drug Act"), the FDA may designate a product as an orphan drug if it is a drug intended to treat a rare disease or condition, which is defined as a patient population of fewer than 200,000 individuals in the United States. We received orphan drug designation from the FDA for mavorixafor for the treatment of WHIM syndrome in October 2018, and from the EMA in July 2019. We also received orphan drug designation in the U.S. for mavorixafor for the treatment of Waldenström's macroglobulinemia in June 2022. If a product with an orphan drug designation subsequently receives the first marketing approval for the indication for which it has such designation, the product is entitled to a seven-year period of marketing exclusivity, which precludes the FDA from approving another marketing application for the same drug for the same indication during that time period with some exceptions. A similar provision in the European Union allows 10 years of exclusivity in Europe. The European exclusivity period can be reduced to six years if a drug no longer meets the criteria for orphan drug designation or if the drug is sufficiently profitable so that marketing exclusivity is no longer justified. Orphan drug exclusivity may be lost in both the United States and Europe under certain situations, such as the inability of the holder of the orphan drug designation to produce sufficient quantities of the drug to meet the needs of patients with the rare disease or condition or for certain other reasons.

The FDA has granted rare pediatric disease designation for mavorixafor for the treatment of WHIM syndrome, however, there is no guarantee that FDA approval of mavorixafor for WHIM will result in a priority review voucher.

In 2012, Congress authorized the FDA to award priority review vouchers to sponsors of certain rare pediatric disease product applications. This program is designed to encourage development of new drug and biological products for prevention and treatment of certain rare pediatric diseases. Specifically, under this program, a sponsor who receives an approval for a drug or biologic for a “rare pediatric disease” that meets certain criteria may qualify for a voucher that can be redeemed to receive a priority review of a subsequent marketing application for a different product. The sponsor of a rare pediatric disease drug product receiving a priority review voucher may transfer (including by sale) the voucher to another sponsor. The voucher may be further transferred any number of times before the voucher is used, as long as the sponsor making the transfer has not yet submitted the application. The FDA may also revoke any priority review voucher if the rare pediatric disease drug for which the voucher was awarded is not marketed in the U.S. within one year following the date of approval.

The FDA has granted rare pediatric disease designation for mavorixafor for the treatment of WHIM syndrome, however, there is no guarantee that we will be able to obtain a priority review voucher, even if mavorixafor is approved by the FDA. Specifically, FDA may not award the voucher to sponsors of marketing applications unless either (i) the drug has received rare pediatric disease designation as of September 30, 2024 and is then approved by the FDA no later than September 30, 2026; or (ii) Congress reauthorizes the program. Even though we received rare pediatric disease designation by the current statutory deadline of September 30, 2024 we may not receive the voucher if we do not obtain approval by September 2026. Even if legislation is enacted that extends the date by which approval of the rare pediatric disease-designated drug must obtain approval to receive a priority review voucher, we may not obtain approval by that date, and even if we do, we may not obtain a priority review voucher.

If we are unable to establish sales and marketing capabilities to market and sell our product candidates, we may be unable to generate any revenue.

Even if we are ultimately successful in obtaining regulatory approval of mavorixafor for the treatment of WHIM syndrome or another indication, in order to market and sell mavorixafor and our other product candidates in development, we currently intend to build and develop our own sales, marketing and distribution operations. Although our management team has previous experience with such efforts, there can be no assurance that we will be successful in building these operations. If we are unable to establish adequate sales, marketing and distribution capabilities, we may not be able to generate product revenue and may not become profitable. We will also be competing with many companies that currently have extensive and well-funded sales and marketing operations. If any of our product candidates are approved, we may be unable to compete successfully against these more established companies.

Our commercial success depends upon attaining significant market acceptance of our product candidates, if approved, among hospitals, physicians, patients and healthcare payors.

Even if we obtain regulatory approval for any of our product candidates that we may develop or acquire in the future, the product may not gain market acceptance among hospitals, physicians, health care payors, patients and the medical community. Market acceptance of any of our product candidates for which we receive approval depends on a number of factors, including:

- the efficacy and safety of such product candidates as demonstrated in clinical trials;
- the clinical indications for which the product candidate is approved;
- acceptance by major operators of hospitals, physicians and patients of the product candidate as a safe and effective treatment, particularly the ability of mavorixafor and our other product candidates to establish themselves as a new standard of care in the treatment paradigm for the indications that we are pursuing;
- the potential and perceived advantages of our product candidates over alternative treatments as compared to the relative costs of the product candidates and alternative treatments;
- the prevalence and severity of any side effects with respect to our product candidates, including mavorixafor;
- our ability to offer any approved products for sale at competitive prices;
- the timing of market introduction of our products as well as competitive products;
- our pricing, and the availability of coverage and adequate reimbursement by third party payors and government authorities;
- relative convenience and ease of administration; and
- the effectiveness of our sales and marketing efforts and those of our potential future collaborators.

There may be delays in getting our product candidates, if approved, on hospital or insurance formularies or limitations on coverages that may be available in the early stages of commercialization for newly approved drugs. If any of our product candidates are approved but fail to achieve market acceptance among hospitals, physicians, patients or health care payors, we will not be able to generate significant revenues, which would have a material adverse effect on our business, prospects, financial condition and results of operations.

Product candidates may cause undesirable side effects that could delay or prevent their marketing approval, limit the commercial profile of an approved label, or result in significant negative consequences following marketing approval, if any, including marketing withdrawal.

Undesirable side effects caused by any of our product candidates that we may develop or acquire could cause us or the FDA or other regulatory authorities to interrupt, delay or halt our clinical trials and could result in more restrictive labels or the delay or denial of marketing approval by the FDA or other regulatory authorities of such product candidates. Results of our clinical trials could reveal a high and unacceptable severity and prevalence of these or other side effects. In such an event, our trials could be suspended or terminated and the FDA or comparable foreign regulatory authorities could order us to cease further development of or deny approval of our product candidates for any or all targeted indications. In addition, any drug-related side effects could affect patient recruitment or the ability of enrolled patients to complete the trial or result in potential product liability claims. Any of these occurrences may harm our business, financial condition and prospects significantly.

Further, clinical trials by their nature utilize a sample of the potential patient population. With a limited number of patients, rare and severe side effects of our product candidates may only be uncovered with a significantly larger number of patients exposed to the product candidate. If our product candidates receive marketing approval and we or others identify undesirable side effects caused by such product candidates (or any other similar drugs) after such approval, a number of potentially significant negative consequences could result, including:

- regulatory authorities may withdraw or limit their approval of such product candidates;
- regulatory authorities may require the addition of labeling statements, such as a “boxed” warning or a contraindication;
- we may be required to create a medication guide outlining the risks of such side effects for distribution to patients;
- we may be required to change the way such product candidates are distributed or administered, conduct additional clinical trials or change the labeling of the product candidates;
- regulatory authorities may require a Risk Evaluation and Mitigation Strategy plan to mitigate risks, which could include medication guides, physician communication plans, or elements to assure safe use, such as restricted distribution methods, patient registries and other risk minimization tools;
- we may be subject to regulatory investigations and government enforcement actions;
- we may decide to remove such product candidates from the marketplace after they are approved;
- we could be sued and held liable for injury caused to individuals exposed to or taking our product candidates; and
- our reputation may suffer.

We believe that any of these events could prevent us from achieving or maintaining market acceptance of the affected product candidates and could substantially increase the costs of commercializing our product candidates, if approved, and significantly impact our ability to successfully commercialize our product candidates and generate revenues.

Any product candidate for which we obtain marketing approval could be subject to marketing restrictions or withdrawal from the market, and we may be subject to penalties if we fail to comply with regulatory requirements or if we experience unanticipated problems with our products.

Any product candidate for which we obtain marketing approval will be subject to continual requirements of and review by the FDA and other regulatory authorities. These requirements include submissions of safety and other post-marketing information and reports, registration and listing requirements, cGMP requirements, quality assurance and corresponding maintenance of records and documents and requirements regarding the distribution of samples to physicians and recordkeeping. Even if marketing approval of a product candidate is granted, the approval may be subject to limitations on the indicated uses for which the product may be marketed or to the conditions of approval, or contain requirements for costly post-marketing testing and surveillance to monitor the safety or efficacy of the medicine. The FDA closely regulates the post-approval marketing and promotion of drugs to ensure that they are marketed only for the approved indications and in accordance with the provisions of the approved labeling.

In addition, later discovery of previously unknown problems with our products, manufacturers or manufacturing processes, or failure to comply with regulatory requirements, may result in, among other things:

- restrictions on such products, manufacturers or manufacturing processes;
- restrictions on the labeling, marketing, distribution or use of a product;
- requirements to conduct post-approval clinical trials;
- warning or untitled letters;
- withdrawal of the products from the market;
- refusal to approve pending applications or supplements to approved applications that we submit;
- recall of products;
- fines, restitution or disgorgement of profits or revenue;
- suspension or withdrawal of marketing approvals;
- refusal to permit the import or export of our products;
- product seizure; and
- injunctions or the imposition of civil or criminal penalties.

If, in the future, we are unable to establish sales and marketing capabilities or to selectively enter into agreements with third parties to sell and market our product candidates, we may not be successful in commercializing our product candidates if and when they are approved.

We do not have a sales or marketing infrastructure and have no experience in the sale, marketing or distribution of pharmaceutical products. To achieve commercial success for any approved product for which we retain sales and marketing responsibilities, we must either develop a sales and marketing organization or outsource these functions to other third parties. In the future, we may choose to build a focused sales and marketing infrastructure to sell some of our product candidates if and when they are approved.

There are risks involved both with establishing our own sales and marketing capabilities and with entering into arrangements with third parties to perform these services. For example, recruiting and training a sales force is expensive and time consuming and could delay any product launch. If the commercial launch of a product candidate for which we recruit a sales force and establish marketing capabilities is delayed or does not occur for any reason, we would have prematurely or unnecessarily incurred these commercialization expenses. This may be costly, and our investment would be lost if we cannot retain or reposition our sales and marketing personnel.

Factors that may inhibit our efforts to commercialize our product candidates on our own include:

- our inability to recruit and retain adequate numbers of effective sales and marketing personnel;
- the inability of sales personnel to obtain access to physicians or educate adequate numbers of physicians on the benefits of prescribing any future products; and
- unforeseen costs and expenses associated with creating an independent sales and marketing organization.

If we enter into arrangements with third parties to perform sales, marketing and distribution services, our product revenue or the profitability of these product revenue to us may be lower than if we were to market and sell any products that we develop ourselves. In addition, we may not be successful in entering into arrangements with third parties to sell and market our product candidates or may be unable to do so on terms that are favorable to us. We may have little control over such third parties, and any of them may fail to devote the necessary resources and attention to sell and market our products effectively. If we do not establish sales and marketing capabilities successfully, either on our own or in collaboration with third parties, we will not be successful in commercializing our product candidates.

We face substantial competition that may result in others discovering, developing or commercializing products before or more successfully than we do.

The development and commercialization of new drug products is highly competitive. We face competition with respect to our current product candidates, and will face competition with respect to any product candidates that we may seek to develop or commercialize in the future, from major pharmaceutical companies, specialty pharmaceutical companies and biotechnology companies worldwide. Some of these competitive products and therapies are based on scientific approaches that are the same as or similar to our approach and others are based on entirely different approaches. Potential competitors also include academic institutions, government agencies and other public and private research organizations that conduct research, seek patent protection

and establish collaborative arrangements for research, development, manufacturing and commercialization.

We are developing our lead product candidate, mavoxixafor, for the treatment of chronic neutropenic disorders, including WHIM syndrome. We are aware of other companies that are developing CXCR4 inhibitors that are in a similar stage of development as mavoxixafor, including BioLineRx, Noxxon, Upsher-Smith, Polyphor and Glycomimetics. To our knowledge, there do not appear to be any competitors with programs in development for WHIM syndrome or chronic neutropenia disorders. With respect to chronic neutropenia, filgrastim injections (human granulocyte colony-stimulating factor (G-CSF)) and two biosimilars (Zarxio and Nivestym) are FDA-approved to reduce the incidence and duration of after effects of severe neutropenia (e.g., fever, infections, oropharyngeal ulcers) in symptomatic patients with congenital neutropenia, cyclic neutropenia, or idiopathic neutropenia.

In many diseases, these drugs are administered in combination to enhance efficacy. Some of the currently approved drug therapies are branded and subject to patent protection, and others are available on a generic basis. Many of these approved drugs are well-established therapies and are widely accepted by physicians, patients and third-party payors. Insurers and other third-party payors may also encourage the use of generic products. We expect that if any of our product candidates are approved, they will be priced at a significant premium over competitive generic products. This may make it difficult for us to achieve our business strategy of using our product candidates in combination with existing therapies or replacing existing therapies with our product candidates.

Our competitors may develop products that are more effective, have a better safety profile, are more convenient or less costly than any that we are developing or that would render our product candidates obsolete or non-competitive. Our competitors may also obtain marketing approval from the FDA or other regulatory authorities for their products sooner than we may obtain approval for our product candidates, which could result in our competitors establishing a strong market position before we are able to enter the market.

Many of our competitors have significantly greater financial resources and expertise in research and development, manufacturing, preclinical testing, conducting clinical trials, obtaining regulatory approvals and marketing approved products than we do. Mergers and acquisitions in the pharmaceutical and biotechnology industries may result in even more resources being concentrated among a smaller number of our competitors. Smaller and other early-stage companies may also prove to be significant competitors, particularly through collaborative arrangements with large and established companies. These third parties may compete with us in recruiting and retaining qualified scientific and management personnel, establishing clinical trial sites and patient registration for clinical trials, as well as in acquiring technologies complementary to, or necessary for, our programs.

Even if we obtain and maintain approval for our product candidates from the FDA, we may never obtain approval for our product candidates outside of the United States, which would limit our market opportunities and could harm our business.

Approval of a product candidate in the United States by the FDA does not ensure approval of such product candidate by regulatory authorities in other countries or jurisdictions, and approval by one foreign regulatory authority does not ensure approval by regulatory authorities in other foreign countries or by the FDA. If regulatory approval is obtained, sales of any future product candidates outside of the United States will be subject to foreign regulatory requirements governing clinical trials and marketing approval. Even if the FDA grants marketing approval for a product candidate, comparable foreign regulatory authorities also must approve the manufacturing and marketing of the product candidate in those countries. Approval procedures vary among jurisdictions and can involve requirements and administrative review periods different from, and more onerous than, those in the United States, including additional preclinical studies or clinical trials. In many countries outside the United States, a product candidate must be approved for reimbursement before it can be approved for sale in that country. In some cases, the price that we intend to charge for any product candidates, if approved, is also subject to approval. Obtaining approval for any future product candidates in the European Union from the European Commission following the opinion of the European Medicines Agency, if we choose to submit a marketing authorization application there, would be a lengthy and expensive process. Even if a product candidate is approved, the FDA or the European Commission, as the case may be, may limit the indications for which the drug may be marketed, require extensive warnings on the drug labeling or require expensive and time-consuming additional clinical trials or reporting as conditions of approval. Obtaining foreign regulatory approvals and compliance with foreign regulatory requirements could result in significant delays, difficulties and costs for us and could delay or prevent the introduction of any future product candidates in certain countries.

Further, clinical trials conducted in one country may not be accepted by regulatory authorities in other countries. Also, regulatory approval for our product candidates may be withdrawn. If we fail to comply with the regulatory requirements, our target market will be reduced and our ability to realize the full market potential of our product candidates will be harmed and our business, financial condition, results of operations and prospects could be harmed.

If we seek approval to commercialize our product candidates outside of the United States, a variety of risks associated with international operations could harm our business.

If we seek approval of our product candidates outside of the United States, we expect that we will be subject to additional risks in commercialization including:

- different regulatory requirements for approval of therapies in foreign countries;
- reduced protection for intellectual property rights;
- unexpected changes in tariffs, trade barriers and regulatory requirements;
- economic weakness, including inflation, or political instability in particular foreign economies and markets;
- compliance with tax, employment, immigration and labor laws for employees living or traveling abroad;
- foreign currency fluctuations, which could result in increased operating expenses and reduced revenues, and other obligations incident to doing business in another country;
- foreign reimbursement, pricing and insurance regimes;
- workforce uncertainty in countries where labor unrest is more common than in the United States;
- production shortages resulting from any events affecting raw material supply or manufacturing capabilities abroad; and
- business interruptions resulting from geopolitical actions, including war and terrorism, or natural disasters and public health epidemics, such as the ongoing COVID-19 pandemic.

We have no prior experience in these areas. In addition, there are complex regulatory, tax, labor and other legal requirements imposed by many of the individual countries in and outside of Europe with which we will need to comply. Many biopharmaceutical companies have found the process of marketing their own products in foreign countries to be very challenging.

Even if we are able to commercialize mavorixafor or any other product candidate that we develop, the product may become subject to unfavorable pricing regulations, third-party reimbursement practices or healthcare reform initiatives, which would harm our business.

The laws and regulations that govern marketing approvals, pricing, coverage and reimbursement for new drug products vary widely from country to country. Current and future legislation may significantly change the approval requirements in ways that could involve additional costs and cause delays in obtaining approvals. Some countries require approval of the sale price of a drug before it can be marketed. In many countries, the pricing review period begins after marketing or product licensing approval is granted and, in some markets, prescription pharmaceutical pricing remains subject to continuing governmental control even after initial approval is granted. As a result, we might obtain marketing approval for a product in a particular country, but then be subject to price regulations that delay our commercial launch of the product, possibly for lengthy time periods, and negatively impact the revenues we are able to generate from the sale of the product in that country. Adverse pricing limitations may hinder our ability to recoup our investment in one or more product candidates, even if our product candidates obtain marketing approval.

Our ability to commercialize mavorixafor or any other product candidate successfully also will depend in part on the extent to which coverage and adequate reimbursement for these products and related treatments will be available from government health administration authorities, private health insurers and other organizations. Government authorities and other third-party payors, such as private health insurers and health maintenance organizations, decide which medications they will pay for and establish reimbursement levels. A primary trend in the U.S. and E.U. healthcare industries and elsewhere is cost containment.

Government authorities and other third-party payors have attempted to control costs by limiting coverage and the amount of reimbursement for particular medications. Increasingly, third-party payors are requiring that drug companies provide them with predetermined discounts from list prices and are challenging the prices charged for medical products. We cannot be sure that coverage and reimbursement will be available for mavorixafor or any other product that we commercialize and, if coverage and reimbursement is available, the level of reimbursement. Reimbursement may impact the demand for, or the price of, any product candidate for which we obtain marketing approval. Obtaining and maintaining adequate reimbursement for mavorixafor may be particularly difficult because of the higher prices typically associated with drugs directed at smaller populations of patients. In addition, third-party payors are likely to impose strict requirements for reimbursement of a higher priced drug, and any launch of a competitive product is likely to create downward pressure on the price initially charged. If reimbursement is not available or is available only to a limited degree, we may not be able to successfully commercialize any product candidate for which we obtain marketing approval. Even if favorable coverage and reimbursement status is attained for one or more products for which we receive regulatory approval, less favorable coverage policies and reimbursement rates may be implemented in the future.

There may be significant delays in obtaining coverage and reimbursement for newly approved drugs, and coverage may be more limited than the purposes for which the drug is approved by the applicable regulatory authority. Moreover, eligibility for coverage and reimbursement does not imply that any drug will be paid for in all cases or at a rate that covers our costs, including research, development, intellectual property, manufacturing, sale and distribution expenses. Interim reimbursement levels for new drugs, if applicable, may also not be sufficient to cover our costs and may not be made permanent.

Reimbursement rates may vary according to the use of the drug and the clinical setting in which it is used, may be based on reimbursement levels already set for lower cost drugs, and may be incorporated into existing payments for other services. Net prices for drugs may be reduced by mandatory discounts or rebates required by government healthcare programs or private payors and by any future relaxation of laws that presently restrict imports of drugs from countries where they may be sold at lower prices than in the United States. In the United States, third-party payors often rely upon Medicare coverage policy and payment limitations in setting their own reimbursement policies. In the European Union, reference pricing systems and other measures may lead to cost containment and reduced prices. Our inability to promptly obtain coverage and adequate reimbursement rates from both government-funded and private payors for any approved products that we develop could have a material adverse effect on our operating results, our ability to raise capital needed to develop product candidates and commercialize products and our overall financial condition.

Governments outside the United States tend to impose strict price controls, which may adversely affect our revenues, if any.

In some countries, particularly the countries of the European Union, the pricing of prescription pharmaceuticals is subject to governmental control. In these countries, pricing negotiations with governmental authorities can take considerable time after the receipt of marketing approval for a product. To obtain reimbursement or pricing approval in some countries, we may be required to conduct a clinical trial that compares the cost-effectiveness of our product candidate to other available therapies. If reimbursement of our products is unavailable or limited in scope or amount, or if pricing is set at unsatisfactory levels, our business could be harmed, possibly materially.

Product liability lawsuits against us could cause us to incur substantial liabilities and could limit the commercialization of any product candidates we may develop.

We face an inherent risk of product liability exposure related to the testing of our product candidates in human clinical trials and will face an even greater risk with respect to commercial sales of any products that we may develop. If we cannot successfully defend ourselves against claims that our product candidates or products caused injuries, we could incur substantial liabilities. Regardless of merit or eventual outcome, liability claims may result in:

- reduced resources of our management to pursue our business strategy;
- decreased demand for any products that we may develop;
- injury to our reputation and significant negative media attention;
- withdrawal of clinical trial participants;
- significant costs to defend any related litigation;
- substantial monetary awards to trial participants or patients;
- loss of revenue;
- increased insurance costs; and
- the inability to commercialize any products that we may develop.

Although we maintain clinical trial insurance coverage, it may not be adequate to cover all liabilities that we may incur. We anticipate that we will need to increase our insurance coverage as we continue clinical trials or begin commercialization of any products. Insurance coverage is increasingly expensive. We may not be able to obtain or maintain insurance coverage at a reasonable cost or in an amount adequate to satisfy any liability that may arise.

Risks Related to Government Regulation

Our relationships with customers and third-party payors will be subject to applicable anti-kickback, fraud and abuse and other healthcare laws and regulations, which could expose us to significant penalties, including administrative, civil and criminal penalties, contractual damages, reputational harm and diminished profits and future earnings.

Although we do not currently have any drugs on the market, we are, and once we begin commercializing our product candidates, we will be subject to additional healthcare statutory and regulatory requirements and enforcement by the federal government and the states and foreign governments in the jurisdictions in which we conduct our business. Healthcare providers and third-party payors will play a primary role in the recommendation and prescription of any product candidates for which we obtain marketing

approval. Our current and future arrangements with third-party payors and customers may expose us to broadly applicable fraud and abuse and other healthcare laws and regulations that may constrain the business or financial arrangements and relationships through which we research, as well as market, sell and distribute any products for which we obtain marketing approval. Restrictions under applicable federal and state healthcare laws and regulations include the following:

- the federal Anti-Kickback Statute prohibits, among other things, persons and entities from knowingly and willfully soliciting, offering, receiving or paying remuneration, directly or indirectly, in cash or in kind, to induce or reward, or in return for, either the referral of an individual for, or the purchase, order or recommendation of, any good or service, for which payment may be made under a federal healthcare program such as Medicare and Medicaid; a person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation;
- the federal false claims laws impose criminal and civil penalties, including civil whistleblower or qui tam actions, against individuals or entities for, among other things, knowingly presenting, or causing to be presented, to the federal government, claims for payment that are false or fraudulent or making a false statement to avoid, decrease or conceal an obligation to pay money to the federal government; in addition, the government may assert that a claim including items and services resulting from a violation of the federal Anti-Kickback Statute constitutes a false or fraudulent claim for purposes of the False Claims Act;
- the federal Health Insurance Portability and Accountability Act of 1996 (“HIPAA”) imposes criminal and civil liability for, among other things, executing a scheme to defraud any healthcare benefit program, or knowingly and willfully falsifying, concealing or covering up a material fact or making any materially false statement in connection with the delivery of or payment for healthcare benefits, items or services; similar to the federal Anti-Kickback Statute, a person or entity does not need to have actual knowledge of the statute or specific intent to violate it in order to have committed a violation;
- the federal physician payment transparency requirements, sometimes referred to as the “Sunshine Act” under the Patient Protection and Affordable Care Act, as amended by the Health Care and Education Reconciliation Act of 2010 (collectively the “ACA”), require certain manufacturers of drugs, devices, biologics and medical supplies that are reimbursable under Medicare, Medicaid, or the Children’s Health Insurance Program to report to the Centers for Medicare & Medicaid Services (“CMS”), information related to payments and other transfers of value to physicians, (defined to include doctors, dentists, optometrists, podiatrists and chiropractors), certain other healthcare professionals (such as physician assistants and nurse practitioners), and teaching hospitals and the ownership and investment interests of physicians and their immediate family members in such manufacturers;
- HIPAA, as amended by the Health Information Technology for Economic and Clinical Health Act and its implementing regulations, which also imposes obligations on certain covered entity healthcare providers, health plans, and healthcare clearinghouses as well as their business associates that perform certain services involving the use or disclosure of individually identifiable health information, and their subcontractors that use, disclose, or otherwise process individually identifiable health information, including mandatory contractual terms, with respect to safeguarding the privacy, security and transmission of individually identifiable health information;
- analogous state and foreign laws and regulations, such as state anti-kickback and false claims laws, may apply to sales or marketing arrangements and claims involving healthcare items or services reimbursed by non-governmental third-party payors, including private insurers;
- some state laws require pharmaceutical companies to comply with the pharmaceutical industry’s voluntary compliance guidelines and the relevant compliance guidance promulgated by the federal government and may require drug manufacturers to report information related to payments and other transfers of value to physicians and other healthcare providers, drug pricing or marketing expenditures;
- state and local laws that require the registration of pharmaceutical sales representatives; and
- state and foreign laws also govern the privacy and security of health information in certain circumstances, many of which differ from each other in significant ways and often are not preempted by HIPAA, thus complicating compliance efforts.

Efforts to ensure that our business arrangements with third parties will comply with applicable healthcare laws and regulations will involve substantial costs. It is possible that governmental authorities will conclude that our business practices may not comply with current or future statutes, regulations or case law involving applicable fraud and abuse or other healthcare laws and regulations. If our operations are found to be in violation of any of these laws or any other governmental regulations that may apply to it, we may be subject to significant civil, criminal and administrative penalties, damages, fines, imprisonment, exclusion from government funded healthcare programs, such as Medicare and Medicaid, additional reporting requirements and/or oversight if we become subject to a corporate integrity agreement or similar agreement to resolve allegations of non-compliance with these laws and the curtailment or restructuring of our operations. If any of the physicians or other healthcare providers or entities with whom we expect to do business is found to be not in compliance with applicable laws, they may be subject to significant criminal, civil or administrative sanctions, including exclusions from government funded healthcare programs.

Current and future legislation may increase the difficulty and cost for us to obtain marketing approval of and commercialize our product candidates and affect the prices we may obtain. In the United States and some foreign jurisdictions, there have been a number of legislative and regulatory changes and proposed changes regarding the healthcare system that could prevent or delay marketing approval of our product candidates, restrict post-approval activities and affect our ability to sell profitably any product candidates for which we obtain marketing approval.

In the United States, Medicare covers certain drug purchases by the elderly and eligible disabled people and introduced a reimbursement methodology based on average sales prices for physician-administered drugs. In addition, Medicare may limit the number of drugs that will be covered in any therapeutic class. Ongoing cost reduction initiatives and future laws could decrease the coverage and price that we will receive for any approved products. While Medicare beneficiaries are limited to most elderly and certain disabled individual, private payors often follow Medicare coverage policy and payment limitations in setting their own payment rates.

In March 2010, the ACA became law. The ACA is a sweeping law intended to broaden access to health insurance, reduce or constrain the growth of healthcare spending, enhance remedies against fraud and abuse, add new transparency requirements for the healthcare and health insurance industries, impose new taxes and fees on the health industry and impose additional health policy reforms. Among the provisions of the ACA of importance to our product candidates are the following:

- an annual, nondeductible fee on any entity that manufactures or imports specified branded prescription drugs and biologic products;
- an increase in the statutory minimum rebates a manufacturer must pay under the Medicaid Drug Rebate Program;
- expansion of healthcare fraud and abuse laws, including the False Claims Act and the Anti-Kickback Statute, new government investigative powers, and enhanced penalties for noncompliance;
- a new Medicare Part D coverage gap discount program, in which manufacturers must agree to offer 70% point-of-sale discounts off negotiated prices;
- extension of manufacturers' Medicaid rebate liability;
- expansion of eligibility criteria for Medicaid programs;
- expansion of the entities eligible for discounts under the Public Health Service Act's pharmaceutical pricing program;
- new requirements to report to CMS financial arrangements with physicians, as defined by such law, and teaching hospitals;
- a new requirement to annually report to FDA drug samples that manufacturers and distributors provide to physicians; and
- a new Patient-Centered Outcomes Research Institute to oversee, identify priorities in, and conduct comparative clinical effectiveness research, along with funding for such research.

There have been challenges to certain aspects of the ACA. In addition, other legislative changes have been proposed and adopted since the ACA was enacted. For example, on June 17, 2021, the U.S. Supreme Court dismissed a challenge on procedural grounds that argued the ACA is unconstitutional in its entirety because the "individual mandate" was repealed by Congress. Prior to the U.S. Supreme Court ruling, on January 28, 2021, President Biden issued an executive order to initiate a special enrollment period for purposes of obtaining health insurance coverage through the ACA marketplace. The executive order also instructed certain governmental agencies to review and reconsider their existing policies and rules that limit access to healthcare, including among others, reexamining Medicaid demonstration projects and waiver programs that include work requirements, and policies that create unnecessary barriers to obtaining access to health insurance coverage through Medicaid or the ACA. In addition, on August

16, 2022, President Biden signed the Inflation Reduction Act of 2022 into law, which among other things, extends enhanced subsidies for individuals purchasing health insurance coverage in ACA marketplaces through plan year 2025. The IRA also eliminates the “donut hole” under the Medicare Part D program beginning in 2025 by significantly lowering the beneficiary maximum out-of-pocket cost and creating a new manufacturer discount program. It is possible that the ACA will be subject to judicial or Congressional challenges in the future. It is unclear how any such challenges and the healthcare reform measures of the Biden administration will impact the ACA and our business.

There has also been heightened governmental scrutiny over the manner in which manufacturers set prices for their marketed products, which has resulted in several Presidential executive orders, Congressional inquiries and proposed bills designed to, among other things, bring more transparency to product pricing, review the relationship between pricing and manufacturer patient programs, and reform government program reimbursement methodologies for drug products. For example, in July 2021, the Biden administration released an executive order, “Promoting Competition in the American Economy,” with multiple provisions aimed at prescription drugs. In response to Biden’s executive order, on September 9, 2021, HHS released a Comprehensive Plan for Addressing High Drug Prices that outlines principles for drug pricing reform and sets out a variety of potential legislative policies that Congress could pursue as well as potential administrative actions HHS can take to advance these principles. In addition, the IRA, among other things, (i) directs HHS to negotiate the price of certain high-expenditure, single-source drugs and biologics covered under Medicare, and subject drug manufacturers to civil monetary penalties and a potential excise tax by offering a price that is not equal to or less than the negotiated “maximum fair price” for such drugs and biologics under the law, and (ii) imposes rebates with respect to certain drugs and biologics covered under Medicare Part B or Medicare Part D to penalize price increases that outpace inflation. The IRA permits HHS to implement many of these provisions through guidance, as opposed to regulation, for the initial years. These provisions will take effect progressively starting in fiscal year 2023, although they may be subject to legal challenges. It is currently unclear how the IRA will be implemented but is likely to have a significant impact on the pharmaceutical industry. Further, the Biden administration released an additional executive order on October 14, 2022, directing HHS to submit a report on how the Center for Medicare and Medicaid Innovation can be further leveraged to test new models for lowering drug costs for Medicare and Medicaid beneficiaries. It is unclear whether this executive order or similar policy initiatives will be implemented in the future. Further, Congress is considering additional health reform measures. At the state level, legislatures have increasingly passed legislation and implemented regulations designed to control pharmaceutical and biological product pricing, including price or patient reimbursement constraints, discounts, restrictions on certain product access and marketing cost disclosure and transparency measures, and, in some cases, designed to encourage importation from other countries and bulk purchasing.

We cannot predict what healthcare reform initiatives may be adopted in the future. However, we expect that the ACA, as well as other healthcare reform measures that may be adopted in the future, may result in more rigorous coverage criteria and in additional downward pressure on the price that we will receive for any approved product. These new laws may result in additional reductions in Medicare and other healthcare funding. Any reduction in payments from Medicare or other government programs may result in a similar reduction in payments from private payors. The implementation of cost containment measures or other healthcare reforms may prevent us from being able to generate revenue, attain profitability, or commercialize our products.

Legislative and regulatory proposals have been made to expand post-approval requirements and restrict sales and promotional activities for pharmaceutical products. We cannot be sure whether additional legislative changes will be enacted, or whether FDA regulations, guidance or interpretations will be changed, or what the impact of such changes on the marketing approvals, if any, of our product candidates may be. In addition, increased scrutiny by the U.S. Congress of the FDA’s approval process may significantly delay or prevent marketing approval, as well as subject us to more stringent product labeling and post-marketing conditions and other requirements.

We are subject to anti-corruption laws, as well as export control laws, customs laws, sanctions laws and other laws governing our operations. If we fail to comply with these laws, we could be subject to civil or criminal penalties, other remedial measures and legal expenses, which could adversely affect its business, results of operations and financial condition.

Our operations are subject to anti-corruption laws, including the Foreign Corrupt Practices Act (“FCPA”) and other anti-corruption laws that apply in countries where we do business and may do business in the future. The FCPA and these other laws generally prohibit us, our officers and employees and intermediaries from bribing, being bribed or making other prohibited payments to government officials or other persons to obtain or retain business or gain some other business advantage. We may in the future operate in jurisdictions that pose a high risk of potential FCPA violations, and may participate in collaborations and relationships with third parties whose actions could potentially subject us to liability under the FCPA or local anti-corruption laws. In addition, we cannot predict the nature, scope or effect of future regulatory requirements to which its international operations might be subject or the manner in which existing laws might be administered or interpreted.

We are also subject to other laws and regulations governing our international operations, including regulations administered by the U.S. government and authorities in the European Union or the United Kingdom, including applicable export control regulations, economic sanctions on countries and persons, customs requirements and currency exchange regulations, which we collectively refer to as Trade Control Laws.

There is no assurance that we will be completely effective in ensuring our compliance with all applicable anti-corruption laws, including the FCPA or other legal requirements, including Trade Control Laws. If we are not in compliance with the FCPA and other anti-corruption laws or Trade Control Laws, we may be subject to criminal and civil penalties, disgorgement and other sanctions and remedial measures, and legal expenses, which could have an adverse impact on our business, financial condition, results of operations and liquidity. Likewise, any investigation of any potential violations of the FCPA, other anti-corruption laws or Trade Control Laws by U.S. or other authorities could also have an adverse impact on our reputation, business, results of operations and financial condition.

Inadequate funding for the FDA, the SEC and other government agencies could hinder their ability to hire and retain key leadership and other personnel, prevent new products and services from being developed or commercialized in a timely manner or otherwise prevent those agencies from performing normal business functions on which the operation of our business may rely, which could negatively impact our business.

The ability of the FDA to review and approve new products can be affected by a variety of factors, including government budget and funding levels, the ability to hire and retain key personnel and accept the payment of user fees, and statutory, regulatory and policy changes. Average review times at the agency have fluctuated in recent years as a result. In addition, government funding of the SEC and other government agencies on which our operations may rely, including those that fund research and development activities is subject to the political process, which is inherently fluid and unpredictable.

Disruptions at the FDA and other agencies may also slow the time necessary for new drugs to be reviewed and/or approved by necessary government agencies, which would adversely affect our business. For example, over the last several years the U.S. government has shut down several times and certain regulatory agencies, such as the FDA and the SEC, have had to furlough critical FDA, SEC and other government employees and stop critical activities. If a prolonged government shutdown occurs, it could significantly impact the ability of the FDA to timely review and process our regulatory submissions, which could have a material adverse effect on our business. Further, in our operations as a public company, future government shutdowns could impact our ability to access the public markets and obtain necessary capital in order to properly capitalize and continue our operations.

Risks Related to Our Dependence on Third Parties

We have no experience manufacturing our product candidates on a large clinical or commercial scale and have no manufacturing facility. We are currently dependent on a single third party manufacturer for the manufacture of mavorixafor, the active pharmaceutical ingredient ("API"), and a single manufacturer of mavorixafor finished drug product capsules. If we experience problems with these third parties, the manufacturing of mavorixafor could be delayed, which could harm our results of operations.

To meet our projected needs for clinical supplies to support our activities through regulatory approval and commercial manufacturing, the manufacturer with whom we currently work will need to increase its frequency and/or scale of production or we will need to find additional or alternative manufacturers. We have not yet secured alternate suppliers in the event the current manufacturer we utilize is unable to meet demand, or if otherwise we experience any problems with them. If such problems arise and we are unable to arrange for alternative third-party manufacturing sources, we are unable to find an alternative third party capable of reproducing the existing manufacturing method or we are unable to do so on commercially reasonable terms or in a timely manner, we may not be able to complete development of our product candidates, or market or distribute them.

Reliance on third-party manufacturers entails risks to which we would not be subject if we manufactured our product candidates ourselves, including reliance on the third party for regulatory compliance and quality assurance, the possibility of breach of the manufacturing agreement by the third party because of factors beyond our control (including a failure to synthesize and manufacture our product candidates or any products that we may eventually commercialize in accordance with our specifications), and the possibility of termination or nonrenewal of the agreement by the third party, based on its own business priorities, at a time that is costly or damaging to us. In addition, the FDA and other regulatory authorities require that our product candidates and any products that we may eventually commercialize be manufactured according to cGMP and similar foreign standards. Drug manufacturers and other entities involved in the manufacture and distribution of approved drugs are required to register their establishments with the FDA and some state agencies, and are subject to periodic unannounced inspections for compliance with cGMP requirements. Changes to the manufacturing process are strictly regulated and often require prior FDA or other regulatory authority approval before being implemented. FDA requirements also require investigation and correction of any deviations from cGMP and impose reporting and documentation requirements upon us and any third-party manufacturers that we may decide to use. Accordingly, the manufacturers must continue to expend time, money and effort in the areas of production and quality

control to maintain cGMP compliance. Any failure by our third-party manufacturers to comply with cGMP or failure to scale up manufacturing processes, including any failure to deliver sufficient quantities of product candidates or products if they are approved in a timely manner, could lead to a delay in, or failure to obtain, regulatory approval of any of our product candidates. In addition, such failure could be the basis for the FDA to issue a warning letter, withdraw approvals for product candidates previously granted to us, or take other regulatory or legal action, including recall or seizure, total or partial suspension of production, suspension of ongoing clinical trials, refusal to approve pending applications or supplemental applications, detention of product, refusal to permit the import or export of products, injunction, or imposing civil and criminal penalties.

Our current manufacturer and any future manufacturers may not be able to manufacture our product candidates at a cost or in quantities or in a timely manner necessary to make commercially successful products. If we successfully commercialize any of our product candidates, we may be required to establish large-scale commercial manufacturing capabilities. In addition, as our drug development pipeline increases and matures, we will have a greater need for clinical study and commercial manufacturing capacity. We have no experience manufacturing pharmaceutical products on a commercial scale and some of these manufacturers will need to increase their scale of production to meet our projected needs for commercial manufacturing, the satisfaction of which may not be met on a timely basis.

We rely on third-party CROs to conduct our preclinical studies and clinical trials. If these CROs do not successfully carry out their contractual duties or meet expected deadlines, we may not be able to obtain regulatory approval for or commercialize our product candidates and our business could be substantially harmed.

We have relied upon and plan to continue to rely upon third-party contract research organizations, or CROs, and clinical data management organizations to monitor and manage data for our ongoing preclinical and clinical programs. Although we control only certain aspects of their activities, we are responsible for ensuring that each of our studies is conducted in accordance with the applicable protocol and legal, regulatory and scientific standards, and our reliance on the CROs does not relieve us of our regulatory responsibilities. We also rely on third parties to conduct our preclinical studies in accordance with Good Laboratory Practice, or GLP, requirements and the Laboratory Animal Welfare Act of 1966 requirements. We, our CROs and our clinical trial sites are required to comply with regulations and current Good Clinical Practices, or GCP, and comparable foreign requirements to ensure that the health, safety and rights of patients are protected in clinical trials, and that data integrity is assured. Regulatory authorities ensure compliance with GCP requirements through periodic inspections of trial sponsors and trial sites. If we, any of our CROs or our clinical trial sites fail to comply with applicable GCP requirements, the clinical data generated in our clinical trials or a specific site may be deemed unreliable and the FDA or comparable foreign regulatory authorities may require us to perform additional clinical trials before approving our marketing applications.

Our CROs are not our employees, and except for remedies available to us under our agreements with such CROs, we cannot control whether or not they devote sufficient time and resources to our ongoing clinical and preclinical programs. If CROs do not successfully carry out their contractual obligations or meet expected timelines or if the quality or accuracy of the clinical data they obtain is compromised due to the failure to adhere to our clinical protocols, regulatory requirements or for other reasons, our clinical trials may be extended, delayed or terminated and we may not be able to obtain regulatory approval for or successfully commercialize our product candidates. As a result, our results of operations and the commercial prospects for our product candidates would be harmed, our costs could increase and our ability to generate revenues could be delayed.

Disruptions in our supply chain could delay the commercial launch of our product candidates.

Any significant disruption in our supplier relationships could harm our business. We currently rely on a single source supplier of mavorixafor, as well as a single supplier for the finished product capsules for mavorixafor. If either of these single source suppliers suffers a major natural or man-made disaster at its manufacturing facility, we would not be able to manufacture mavorixafor on a commercial scale until a qualified alternative supplier is identified. Although alternative sources of supply exist, the number of third party suppliers with the necessary manufacturing and regulatory expertise and facilities is limited, and it could be expensive and take a significant amount of time to arrange for alternative suppliers. Any significant delay in the supply of a product candidate or its key materials for an ongoing clinical study could considerably delay completion of our clinical studies, product testing and potential regulatory approval of our product candidates. If we or our manufacturers are unable to purchase these key materials after regulatory approval has been obtained for our product candidates, the commercial launch of our product candidates would be delayed, which would impair our ability to generate revenues from the sale of our product candidates.

Our employees, principal investigators, CROs and consultants may engage in misconduct or other improper activities, including noncompliance with regulatory standards and requirements, which could have a material adverse effect on our business.

We are exposed to the risk that our employees, principal investigators, CROs and consultants may engage in fraudulent conduct or other illegal activity. Misconduct by these parties could include intentional failures to comply with FDA regulations or similar regulations of comparable foreign regulatory authorities, to provide accurate information to the FDA or comparable foreign regulatory authorities, to comply with manufacturing standards we have established, to comply with federal and state healthcare fraud and abuse laws and regulations and similar laws and regulations established and enforced by comparable foreign regulatory

authorities, to report financial information or data accurately or to disclose unauthorized activities to us. In particular, sales, marketing and business arrangements in the healthcare industry are subject to extensive laws and regulations intended to prevent fraud, kickbacks, self-dealing and other abusive practices. These laws and regulations may restrict or prohibit a wide range of pricing, discounting, marketing and promotion, sales commission, customer incentive programs and other business arrangements. Employee or third party misconduct could also involve the improper use of information obtained in the course of clinical trials, which could result in regulatory sanctions and serious harm to our reputation. It is not always possible to identify and deter employee misconduct and the precautions we take to detect and prevent this activity, such as employee training, may not be effective in controlling unknown or unmanaged risks or losses or in protecting us from governmental investigations or other actions or lawsuits stemming from a failure to be in compliance with such laws or regulations. If any such actions are instituted against us, and we are not successful in defending ourselves or asserting our rights, those actions could have a significant impact on our business and results of operations, including the imposition of significant fines or other sanctions.

We have established, and may seek to selectively establish in the future, collaborations, and, if we are unable to establish them on commercially reasonable terms, we may have to alter our development and commercialization plans.

Our drug development programs and the potential commercialization of our product candidates will require substantial additional cash to fund expenses. For some of our product candidates, we may decide to collaborate with pharmaceutical and biotechnology companies for the development and potential commercialization of those product candidates.

We face significant competition in seeking appropriate collaborators. Whether we reach a definitive agreement for a collaboration will depend, among other things, upon our assessment of the collaborator's resources and expertise, the terms and conditions of the proposed collaboration and the proposed collaborator's evaluation of a number of factors. Those factors may include the design or results of clinical trials, the likelihood of approval by the FDA or similar regulatory authorities outside the United States, the potential market for the subject product candidate, the costs and complexities of manufacturing and delivering such product candidate to patients, the potential of competing products, the existence of uncertainty with respect to our ownership of technology, which can exist if there is a challenge to such ownership without regard to the merits of the challenge and industry and market conditions generally. The collaborator may also consider alternative product candidates for similar indications that may be available to collaborate on and whether such a collaboration could be more attractive than the one with us for our product candidates.

We may depend on such collaborations for the development and commercialization of our product candidates. If those collaborations are not successful, we may not be able to capitalize on the market potential of our product candidates.

We have, and may selectively seek in the future, third-party collaborators for the development and commercialization of our product candidates. Our likely collaborators for any collaboration arrangements include large and mid-size pharmaceutical companies, regional and national pharmaceutical companies and biotechnology companies. If we enter into any such arrangements with any third parties, we will likely have limited control over the amount and timing of resources that our collaborators dedicate to the development or commercialization of our product candidates. Our ability to generate revenue from these arrangements will depend on our collaborators' abilities to successfully perform the functions assigned to them in these arrangements.

Collaborations involving our product candidates pose many risks to us, including that:

- collaborators have significant discretion in determining the efforts and resources that they will apply to these collaborations;
- collaborators may not pursue development and commercialization of our product candidates or may elect not to continue or renew development or commercialization programs based on clinical trial results, changes in the collaborator's strategic focus or available funding or external factors such as an acquisition that diverts resources or creates competing priorities;
- collaborators may delay clinical trials, provide insufficient funding for a clinical trial program, stop a clinical trial or abandon a product candidate, repeat or conduct new clinical trials or require a new formulation of a product candidate for clinical testing;
- collaborators could independently develop, or develop with third parties, products that compete directly or indirectly with our product candidates or products if the collaborators believe that competitive products are more likely to be successfully developed or can be commercialized under terms that are more economically attractive than ours;
- collaborators with marketing and distribution rights to one or more product candidates or products may not commit sufficient resources to the marketing and distribution of such drugs;

- collaborators may not properly maintain or defend our intellectual property rights or may use our proprietary information in such a way as to invite litigation that could jeopardize or invalidate our proprietary information or expose us to potential litigation;
- disputes may arise between the collaborators and us that result in the delay or termination of the research, development or commercialization of our product candidates or products or that result in costly litigation or arbitration that diverts management attention and resources;
- we may lose certain valuable rights under circumstances identified in our collaborations if we undergo a change of control;
- collaborations may be terminated and, if terminated, may result in a need for additional capital to pursue further development or commercialization of the applicable product candidates; and
- collaboration agreements may not lead to development or commercialization of product candidates in the most efficient manner or at all. In addition, if a future collaborator of ours were to be involved in a business combination, the continued pursuit and emphasis on our product development or commercialization program under such collaboration could be delayed, diminished or terminated.

Risks Related to Our Intellectual Property

Recent laws and rulings by U.S. courts make it difficult to predict how patents will be issued or enforced in our industry.

Changes in either the patent laws or interpretation of the patent laws in the United States and other countries may have a significant impact on our ability to protect our technology and enforce our intellectual property rights.

There have been numerous changes over the past ten years to the patent laws and to the rules of the United States Patent and Trademark Office (“USPTO”), which may have a significant impact on our ability to protect our technology and enforce our intellectual property rights. For example, the Leahy-Smith America Invents Act (“AIA”), which was signed into law in 2011, includes a transition from a “first-to-invent” system to a “first-to-file” system, and changes the way issued patents are challenged. Certain changes, such as the institution of inter partes review proceedings, that allow third parties to challenge newly issued patents, came into effect on September 16, 2012. The burden of proof required for challenging a patent in these proceedings is lower than in district court litigation, and patents in the biologics and pharmaceuticals industry have been successfully challenged using these new post-grant challenges. In addition, the U.S. Supreme Court has ruled on several patent cases in recent years, either narrowing the scope of patent protection available in specified circumstances or weakening the rights of patent owners in specified situations. Depending on decisions by the U.S. Congress, the federal courts, and the USPTO, these substantive changes to patent law associated with the AIA may further weaken our ability to obtain new patents or to enforce our existing patents and patents that we might obtain in the future, all of which could harm our business.

Furthermore, the patent positions of companies engaged in the development and commercialization of biologics and pharmaceuticals are particularly uncertain. We cannot assure you that our efforts to seek patent protection for our technology and products will not be negatively impacted by the changes described above, future rulings in district court cases or changes in guidance or procedures issued by the USPTO. We cannot fully predict what impact the Supreme Court’s decisions may have on the ability of life science companies to obtain or enforce patents relating to their products and technologies in the future.

Moreover, although the Supreme Court has held in *Myriad* that isolated segments of naturally occurring DNA are not patent-eligible subject matter, certain third parties could allege that activities that we may undertake infringe other gene-related patent claims, and we may deem it necessary to defend ourselves against these claims by asserting non-infringement and/or invalidity positions, or pay to obtain a license to these claims. In any of the foregoing or in other situations involving third-party intellectual property rights, if we are unsuccessful in defending against claims of patent infringement, we could be forced to pay damages or be subjected to an injunction that would prevent us from utilizing the patented subject matter. Such outcomes could harm our business.

If we are unable to protect our intellectual property rights, our competitive position could be harmed.

We depend on our ability to protect our proprietary technology. We rely on trade secret, patent, copyright and trademark laws, and confidentiality, licensing and other agreements with employees and third parties, all of which offer only limited protection. Our success depends in large part on our ability to obtain and maintain patent protection in the United States and other countries with respect to our proprietary technology and products. Where we have the right to do so under our license agreements, we seek to protect our proprietary position by filing patent applications in the United States and abroad related to our novel technologies and products that are important to our business.

The patent positions of biotechnology and pharmaceutical companies generally are highly uncertain, involve complex legal and factual questions and have in recent years been the subject of much litigation. As a result, the issuance, scope, validity, enforceability and commercial value of our patents, including those patent rights licensed to us by third parties, are highly uncertain.

The steps we have taken to police and protect our proprietary rights may not be adequate to preclude misappropriation of our proprietary information or infringement of our intellectual property rights, both inside and outside the United States. The rights already granted under any of our currently issued patents and those that may be granted under future issued patents may not provide us with the proprietary protection or competitive advantages that we are seeking. If we are unable to obtain and maintain patent protection for our technology and products, or if the scope of the patent protection obtained is not sufficient, our competitors could develop and commercialize technology and products similar or superior to ours, and our ability to successfully commercialize our technology and products may be adversely affected.

With respect to patent rights, we do not know whether any of the pending patent applications for any of our product candidates will result in the issuance of patents that protect our technology or products, or which will effectively prevent others from commercializing competitive technologies and products. Our pending applications cannot be enforced against third parties practicing the technology claimed in such applications unless and until a patent issues from such applications. Further, the examination process may require us or our licensors to narrow the claims, which may limit the scope of patent protection that may be obtained. Although our license agreement with Genzyme includes a number of issued patents that are exclusively licensed to us, the issuance of a patent is not conclusive as to its inventorship, scope, validity or enforceability, issued patents that we own or have licensed from third parties may be challenged in the courts or patent offices in the United States and abroad. Such challenges may result in the loss of patent protection, the narrowing of claims in such patents, or the invalidity or unenforceability of such patents, which could limit our ability to stop others from using or commercializing similar or identical technology and products, or limit the duration of the patent protection for our technology and products. Protecting against the unauthorized use of our patented technology, trademarks and other intellectual property rights is expensive, difficult and may, in some cases, not be possible. In some cases, it may be difficult or impossible to detect third party infringement or misappropriation of our intellectual property rights, even in relation to issued patent claims, and proving any such infringement may be even more difficult.

We could be required to incur significant expenses to obtain our intellectual property rights, and we cannot ensure that we will obtain meaningful patent protection for our product candidates.

The patent prosecution process is expensive and time-consuming, and we may not be able to file and prosecute all necessary or desirable patent applications at a reasonable cost or in a timely manner. In addition, it is also possible that we will fail to identify patentable aspects of further inventions made in the course of our development and commercialization activities before they are publicly disclosed, making it too late to obtain patent protection on them. Further, given the amount of time required for the development, testing and regulatory review of new product candidates, patents protecting such candidates might expire before or shortly after such candidates are commercialized. We expect to seek extensions of patent terms where these are available in any countries where we are prosecuting patents. This includes in the United States under the Drug Price Competition and Patent Term Restoration Act of 1984, which permits a patent term extension of up to five years beyond the expiration of a patent that covers an approved product where the permission for the commercial marketing or use of the product is the first permitted commercial marketing or use, and as long as the remaining term of the patent does not exceed 14 years. However, the applicable authorities, including the FDA in the United States, and any equivalent regulatory authority in other countries, may not agree with our assessment of whether such extensions are available, and may refuse to grant extensions to our patents, or may grant more limited extensions than we request. If this occurs, our competitors may be able to take advantage of our investment in development and clinical trials by referencing our clinical and preclinical data and launch their product earlier than might otherwise be the case. Changes in either the patent laws or interpretation of the patent laws in the United States and other countries may diminish the value of our patents or narrow the scope of our patent protection. The laws of foreign countries may not protect our rights to the same extent as the laws of the United States, and these foreign laws may also be subject to change. Publications of discoveries in the scientific literature often lag behind the actual discoveries, and patent applications in the United States and other jurisdictions are typically not published until 18 months after filing or in some cases not at all. Therefore, we cannot be certain that we or our licensors were the first to make the inventions claimed in our owned or licensed patents or pending patent applications, or that we or our licensors were the first to file for patent protection of such inventions.

Obtaining and maintaining our patent protection depends on compliance with various procedural, documentary, fee payment and other requirements imposed by governmental patent agencies, and our patent protection could be reduced or eliminated for non-compliance with these requirements.

Periodic maintenance fees on any issued patent are due to be paid to the USPTO, and foreign patent agencies in several stages over the lifetime of the patent. The USPTO and various foreign governmental patent agencies require compliance with a number of procedural, documentary, fee payment and other requirements during the patent application process. While an inadvertent lapse can in many cases be cured by payment of a late fee or by other means in accordance with the applicable rules, there are situations in which noncompliance can result in abandonment or lapse of the patent or patent application, resulting in partial or complete loss of patent rights in the relevant jurisdiction. Non-compliance events that could result in abandonment or lapse of a patent or

patent application include, but are not limited to, failure to respond to official actions within prescribed time limits, non-payment of fees and failure to properly legalize and submit formal documents. If we or our licensors fail to maintain the patents and patent applications covering our product candidates, our competitors might be able to enter the market, which would have a material adverse effect on our business.

Patent terms may be inadequate to protect our competitive position on our product candidates for an adequate amount of time.

Patents have a limited lifespan. In the United States, if all maintenance fees are timely paid, the natural expiration of a patent is generally 20 years from its earliest U.S. non-provisional filing date. Various extensions may be available, but the life of a patent, and the protection it affords, is limited. Even if patents covering our product candidates are obtained, once the patent life has expired, we may be open to competition from competitive products, including generics or biosimilars. Given the amount of time required for the development, testing and regulatory review of new product candidates, patents protecting such candidates might expire before or shortly after such candidates are commercialized. As a result, our owned and licensed patent portfolio may not provide us with sufficient rights to exclude others from commercializing products similar or identical to ours.

We may become involved in lawsuits to protect or enforce our intellectual property, which could be expensive, time consuming and unsuccessful.

In addition to the possibility of litigation relating to infringement claims asserted against it, we may become a party to other patent litigation and other proceedings, including inter partes review proceedings, post-grant review proceedings, derivation proceedings declared by the USPTO and similar proceedings in foreign countries, regarding intellectual property rights with respect to our current or future technologies or product candidates or products. The cost to us of any patent litigation or other proceeding, even if resolved in our favor, could be substantial. Some of our competitors may be able to sustain the costs of such litigation or proceedings more effectively than we can because of their substantially greater financial resources. Patent litigation and other proceedings may also absorb significant management time. Uncertainties resulting from the initiation and continuation of patent litigation or other proceedings could impair our ability to compete in the marketplace.

Competitors may infringe or otherwise violate our intellectual property, including patents that may issue to or be licensed by us. As a result, we may be required to file claims in an effort to stop third-party infringement or unauthorized use. Any such claims could provoke these parties to assert counterclaims against us, including claims alleging that we infringe their patents or other intellectual property rights. This can be prohibitively expensive, particularly for a company of our size, and time-consuming, and even if we are successful, any award of monetary damages or other remedy we may receive may not be commercially valuable. In addition, in an infringement proceeding, a court may decide that our asserted intellectual property is not valid or is unenforceable, or may refuse to stop the other party from using the technology at issue on the grounds that our intellectual property does not cover its technology. An adverse determination in any litigation or defense proceedings could put our intellectual property at risk of being invalidated or interpreted narrowly and could put our patent applications at risk of not issuing.

If the breadth or strength of our patent or other intellectual property rights is compromised or threatened, it could allow third parties to commercialize our technology or products or result in our inability to commercialize our technology and products without infringing third-party intellectual property rights. Further, third parties may be dissuaded from collaborating with us.

Interference or derivation proceedings brought by the USPTO or its foreign counterparts may be necessary to determine the priority of inventions with respect to our patent applications, and we may also become involved in other proceedings, such as re-examination proceedings, before the USPTO or its foreign counterparts. Due to the substantial competition in the pharmaceutical space, the number of such proceedings may increase. This could delay the prosecution of our pending patent applications or impact the validity and enforceability of any future patents that we may obtain. In addition, any such litigation, submission or proceeding may be resolved adversely to us and, even if successful, may result in substantial costs and distraction to our management.

Furthermore, because of the substantial amount of discovery required in connection with intellectual property litigation, there is a risk that some of our confidential information could be compromised by disclosure during this type of litigation. Moreover, intellectual property law relating to the fields in which we operate is still evolving and, consequently, patent and other intellectual property positions in our industry are subject to change and are often uncertain. We may not prevail in any of these suits or other efforts to protect our technology, and the damages or other remedies awarded, if any, may not be commercially valuable. During the course of this type of litigation, there could be public announcements of the results of hearings, motions or other interim proceedings or developments. If securities analysts or investors perceive these results to be negative, the market price for our common stock could be significantly harmed.

If we fail to comply with our obligations in the agreements under which we license intellectual property rights from third parties or otherwise experience disruptions to our business relationships with our licensors, we could lose intellectual property rights that are important to our business.

We are a party to several license agreements and may need to obtain additional licenses from others to advance our research and

development activities or allow the commercialization of our current product candidates and any that we may identify and pursue in the future. Our currently license agreements impose, and we expect that future license agreements will impose, various development, diligence, commercialization, and other obligations on us. In spite of our efforts, our licensors might conclude that we have materially breached our obligations under such license agreements and might therefore terminate the license agreements, thereby removing or limiting our ability to develop and commercialize products and technology covered by these license agreements. If these in-licenses are terminated, or if the underlying patents fail to provide the intended exclusivity, competitors or other third parties may gain the freedom to seek regulatory approval of, and to market, products identical to ours and we may be required to cease our development and commercialization of our product candidates. Any of the foregoing could have a material adverse effect on our competitive position, business, financial conditions, results of operations, and prospects.

Moreover, disputes may arise regarding intellectual property subject to a licensing agreement, including:

- the scope of rights granted under the license agreement and other interpretation-related issues;
- the extent to which our product candidates, technology and processes infringe on intellectual property of the licensor that is not subject to the licensing agreement;
- the sublicensing of patent and other rights under our collaborative development relationships;
- our diligence obligations under the license agreement and what activities satisfy those diligence obligations;
- the inventorship and ownership of inventions and know-how resulting from the joint creation or use of intellectual property by our licensors and us and our partners; and
- the priority of invention of patented technology.

In addition, the agreements under which we currently license intellectual property or technology from third parties are complex, and certain provisions in such agreements may be susceptible to multiple interpretations. The resolution of any contract interpretation disagreement that may arise could narrow what we believe to be the scope of our rights to the relevant intellectual property or technology, or increase what we believe to be our financial or other obligations under the relevant agreement, either of which could have a material adverse effect on our business, financial condition, results of operations, and prospects. Moreover, if disputes over intellectual property that we have licensed prevent or impair our ability to maintain our current licensing arrangements on commercially acceptable terms, we may be unable to successfully develop and commercialize the affected product candidates, which could have a material adverse effect on our business, financial conditions, results of operations, and prospects.

From time to time, we may need to rely on licenses to proprietary technologies, which may be difficult or expensive to obtain or we may lose certain licenses which may be difficult to replace.

We may need to obtain licenses to patents and other proprietary rights held by third parties to develop, manufacture and market our product candidates. If we are unable to timely obtain these licenses on commercially reasonable terms and maintain these licenses, our ability to commercially market our product candidates may be inhibited or prevented, which could have a material adverse effect on our business, results of operations, financial condition and cash flows.

Third parties may initiate legal proceedings alleging that we are infringing their intellectual property rights, the outcome of which would be uncertain and could have a material adverse effect on the success of our business.

Our commercial success depends upon our ability to develop, manufacture, market and sell our product candidates, and to use our proprietary technologies without infringing the proprietary rights of third parties. We may become party to, or threatened with, future adversarial proceedings or litigation regarding intellectual property rights with respect to our products and technology, including interference and various post grant proceedings before the USPTO, non-U.S. opposition proceedings, and German nullity proceedings. Third parties may assert infringement claims against us based on existing patents or patents that may be granted in the future.

As a result of any such infringement claims, or to avoid potential claims, we may choose or be compelled to seek intellectual property licenses from third parties. These licenses may not be available on acceptable terms, or at all. Even if we are able to obtain a license, the license would likely obligate us to pay license fees or royalties or both, and the rights granted to us likely would be nonexclusive, which would mean that our competitors also could obtain licenses to the same intellectual property. Ultimately, we could be prevented from commercializing a product candidate or technology or be forced to cease some aspect of our business operations if, as a result of actual or threatened infringement claims, we are unable to enter into licenses of the relevant intellectual property on acceptable terms. Further, if we attempt to modify a product candidate or technology or to develop alternative methods or products in response to infringement claims or to avoid potential claims, we could incur substantial costs, encounter delays in product introductions or interruptions in sales. Ultimately, such efforts could be unsuccessful.

Parties making claims against us may obtain injunctive or other equitable relief, which could effectively block our ability to further develop and commercialize our product candidates that we may identify. Defense of these claims, regardless of their merit, would involve substantial litigation expense and would be a substantial diversion of employee resources from our business. In the event of a successful claim of infringement against us, we may have to pay substantial damages, including treble damages and attorneys' fees for willful infringement, pay royalties, redesign our infringing products or obtain one or more licenses from third parties, which may be impossible or require substantial time and monetary expenditure.

Parties making claims against us may be able to sustain the costs of complex patent litigation more effectively than we can because they have substantially greater resources. Furthermore, because of the substantial amount of discovery required in connection with intellectual property litigation or administrative proceedings, there is a risk that some of our confidential information could be compromised by disclosure. In addition, any uncertainties resulting from the initiation and continuation of any litigation could have material adverse effect on our ability to raise additional funds or otherwise have a material adverse effect on our business, results of operations, financial condition and prospects.

Intellectual property litigation could cause us to spend substantial resources and distract our personnel from their normal responsibilities.

Litigation or other legal proceedings relating to intellectual property claims, with or without merit, is unpredictable and generally expensive and time consuming and is likely to divert significant resources from our core business, including distracting our technical and management personnel from their normal responsibilities. Furthermore, because of the substantial amount of discovery required in connection with intellectual property litigation, there is a risk that some of our confidential information could be compromised by disclosure during this type of litigation. In addition, there could be public announcements of the results of hearings, motions or other interim proceedings or developments and if securities analysts or investors perceive these results to be negative, it could have a substantial adverse effect on the price of our common stock and negatively impact our ability to raise additional funds. Such litigation or proceedings could substantially increase our operating losses and reduce the resources available for development activities or any future sales, marketing or distribution activities.

We may not have sufficient financial or other resources to adequately conduct such litigation or proceedings. Some of our competitors may be able to sustain the costs of such litigation or proceedings more effectively than we can because of their greater financial resources and more mature and developed intellectual property portfolios. Accordingly, despite our efforts, we may not be able to prevent third parties from infringing upon or misappropriating or from successfully challenging our intellectual property rights. Uncertainties resulting from the initiation and continuation of patent litigation or other proceedings could have a material adverse effect on our ability to compete in the marketplace.

Our trade secrets are difficult to protect and if we are unable to protect the confidentiality of our trade secrets, our business and competitive position would be harmed.

In addition to seeking patents for some of our technologies and product candidates, we also rely on trade secrets, including unpatented know-how, technology and other proprietary information, to maintain our competitive position. We seek to protect these trade secrets, in part, by entering into non-disclosure and confidentiality agreements with parties who have access to them, such as our employees, corporate collaborators, outside scientific collaborators, contract manufacturers, consultants, advisors and other third parties. We also enter into confidentiality, non-competition, non-solicitation, and invention assignment agreements with our employees and consultants that obligate them to assign to us any inventions developed in the course of their work for us. However, we cannot guarantee that we have executed these agreements with each party that may have or have had access to our trade secrets or that the agreements we have executed will provide adequate protection. Despite these efforts, any of these parties may breach the agreements and disclose our proprietary information, including our trade secrets, and we may not be able to obtain adequate remedies for such breaches. As a result, we may be forced to bring claims against third parties, or defend claims that they bring against us, to determine ownership of what we regard as our intellectual property. Monitoring unauthorized disclosure is difficult and we do not know whether the procedures that we have followed to prevent such disclosure are or will be adequate. Enforcing a claim that a party illegally disclosed or misappropriated a trade secret is difficult, expensive and time-consuming, and the outcome is unpredictable. In addition, some courts inside and outside the United States may be less willing or unwilling to protect trade secrets. If any of the technology or information that we protect as trade secrets were to be lawfully obtained or independently developed by a competitor, we would have no right to prevent them from using that technology or information to compete with us. If any of our trade secrets were to be disclosed to, or independently developed by, a competitor, our competitive position would be harmed.

We may be subject to claims that our employees have wrongfully used or disclosed alleged trade secrets of their former employers.

Our employees, including members of our senior management, were previously employed at other biotechnology or pharmaceutical companies, including our competitors or potential competitors. All such individuals, including each member of our senior management, executed proprietary rights, non-disclosure and non-competition agreements in connection with such previous employment. Although we try to ensure that our employees do not use the proprietary information or know-how of others in their work for us, we may be subject to claims that we or these employees have used or disclosed intellectual property, including trade secrets or other proprietary information, of any such employee's former employer. We are not aware of any threatened or pending claims related to these matters or concerning the agreements with our senior management, but in the future litigation may be necessary to defend against such claims. If we fail in defending any such claims, in addition to paying monetary damages, we may lose valuable intellectual property rights or personnel. Even if we are successful in defending against such claims, litigation could result in substantial costs and be a distraction to management.

We may not be able to protect our intellectual property rights throughout the world.

Filing, prosecuting and defending patents on all of our product candidates throughout the world would be prohibitively expensive. In general, we have sought patent protection of our intellectual property in the following jurisdictions: US, Canada, China, Japan and in countries within Europe via the European Patent Office. Competitors may use our technologies in jurisdictions where we have not obtained patent protection to develop their own products and further, may export otherwise infringing products to territories where we have patent protection, but where enforcement is not as strong as that in the United States. These products may compete with our products in jurisdictions where we do not have any issued patents and our patent claims or other intellectual property rights may not be effective or sufficient to prevent them from so competing.

Many companies have encountered significant problems in protecting and defending intellectual property rights in foreign jurisdictions. The legal systems of certain countries, particularly certain developing countries, do not favor the enforcement of patents and other intellectual property protection, particularly those relating to biopharmaceuticals, which could make it difficult for us to stop the infringement of our patents or marketing of competing products in violation of our proprietary rights generally. Proceedings to enforce our patent rights in foreign jurisdictions could result in substantial cost and divert our efforts and attention from other aspects of our business.

As another example, the complexity and uncertainty of European patent laws have increased in recent years. In Europe, a new unitary patent system will likely be introduced by the end of 2023, which would significantly impact European patents, including those granted before the introduction of such a system. Under the unitary patent system, European applications will soon have the option, upon grant of a patent, of becoming a Unitary Patent which will be subject to the jurisdiction of the Unitary Patent Court ("UPC"). As the UPC is a new court system, there is no precedent for the court, increasing the uncertainty of any litigation. Patents granted before the implementation of the UPC will have the option of opting out of the jurisdiction of the UPC and remaining as national patents in the UPC countries. Patents that remain under the jurisdiction of the UPC will be potentially vulnerable to a single UPC-based revocation challenge that, if successful, could invalidate the patent in all countries who are signatories to the UPC. We cannot predict with certainty the long-term effects of any potential changes.

Risks Related to Our Business Operations, Employee Matters and Managing Growth

Our future success depends on our ability to retain executives and to attract, retain and motivate key personnel in a competitive environment for skilled biotechnology personnel.

Because of the specialized scientific and managerial nature of our business, we rely heavily on our ability to attract and retain qualified scientific, technical and managerial personnel. We are also highly dependent upon members of our current management team, including Paula Ragan, Ph.D., our Chief Executive Officer. The loss of the services provided by these individuals will adversely impact the achievement of our objectives. These individuals could leave our employment at any time, as they are "at will" employees. Effective succession planning is also important to our long-term success. Failure to ensure effective transfer of knowledge and smooth transitions involving key employees could hinder our strategic planning and execution. For example, our former Chief Medical Officer resigned in November 2022 and we have engaged an interim Chief Medical Officer while we complete a search for a permanent Chief Medical Officer. While we expect to engage in an orderly transition process if and when we integrate newly appointed officers and managers, we face a variety of risks and uncertainties relating to management transition, including diversion of management attention from business concerns, failure to retain other key personnel, or loss of institutional knowledge. In addition, the loss of the services of any of our executive officers, other key employees, and other scientific and medical advisors, and an inability to find suitable replacements could result in delays in product development, and harm our business.

Our success will depend on our ability to retain our management team and other key employees, and to attract and retain qualified personnel in the future. The loss of the services of certain members of our senior management or key employees could prevent or delay the implementation and completion of our strategic objectives, or divert management's attention to seeking qualified replacements. The competition for qualified personnel in the pharmaceutical field is intense and we cannot guarantee that we will be able to retain our current personnel or attract and retain new qualified personnel necessary for the development of our business or to recruit suitable replacement personnel.

We will need to grow the size of our organization, and we may experience difficulties in managing this growth.

As of December 31, 2022, we had 70 full-time employees. Although we announced a reduction in workforce of approximately 20% in July 2022 as part of our streamlining of resources to focus on advancing our lead clinical candidate, mavorixafor, as our development and commercialization plans and strategies develop, or as a result of any future acquisitions, we will need additional managerial, operational, development, sales, marketing, financial and other resources. Our management, personnel and systems currently in place will not be adequate to support this future growth. Future growth would impose significant added responsibilities on our employees, including:

- managing our clinical trials effectively;
- identifying, recruiting, maintaining, motivating and integrating additional employees;
- managing our internal development efforts effectively while complying with our contractual obligations to licensors, contractors and other third parties;
- improving our managerial, development, operational and finance systems; and
- expanding our facilities.

As our operations expand, we will need to manage additional relationships with various strategic collaborators, suppliers and other third parties. Our future financial performance and our ability to commercialize our product candidates and to compete effectively will depend, in part, on our ability to manage any future growth effectively. To that end, we must be able to manage our development efforts and clinical trials effectively and hire, train and integrate additional management, administrative, research and development, and sales and marketing personnel. We may not be able to accomplish these tasks, and our failure to accomplish any of them could prevent us from successfully growing the company.

The pharmaceutical industry is highly competitive and is subject to rapid and significant technological change, which could render our technologies and products obsolete or uncompetitive.

The pharmaceutical industry is highly competitive and is subject to rapid and significant technological change, which could render certain of our products obsolete or uncompetitive. This is particularly true in the development of therapeutics for oncology indications where new products and combinations of products are rapidly being developed that change the treatment paradigm for patients. There is no assurance that our product candidates will be the best, have the best safety profile, be the first to market, or be the most economical to make or use. The introduction of competitive therapies as alternatives to our product candidates could dramatically reduce the value of those development projects or chances of successfully commercializing those product candidates, which could have a material adverse effect on our long-term financial success.

We will compete with companies in the United States and internationally, including major pharmaceutical and chemical companies, specialized CROs, research and development firms, universities and other research institutions. Many of our competitors have greater financial resources and selling and marketing capabilities, greater experience in clinical testing and human clinical trials of pharmaceutical products and greater experience in obtaining FDA and other regulatory approvals than we do. In addition, some of our competitors may have lower development and manufacturing costs.

We rely significantly on information technology and any failure, inadequacy, interruption or security lapse of that technology or loss of data, including any cyber security incidents, could compromise sensitive information related to our business, prevent us from accessing critical information or expose us to liability which could harm our ability to operate our business effectively and adversely affect our business and reputation.

In the ordinary course of our business, we, our contract research organizations and other third parties on which we rely collect and store sensitive data, including legally protected patient health information, personally identifiable information about our employees, intellectual property, and proprietary business information. We manage and maintain our applications and data utilizing on-site systems. These applications and data encompass a wide variety of business-critical information including research and development information and business and financial information.

The secure processing, storage, maintenance and transmission of this critical information is vital to our operations and business strategy. Additionally, despite the implementation of security measures, our internal computer systems and those of third parties with which we contract are vulnerable to damage from cyber-attacks, computer viruses, breaches, unauthorized access, interruptions due to employee error or malfeasance or other disruptions, or damage from natural disasters, terrorism, war and telecommunication and electrical failures.

In addition, we have implemented a work model that has enabled substantially all of our employees to periodically work remotely, which may make us more vulnerable to cyberattacks. Any such event could compromise our networks and the information stored there could be accessed by unauthorized parties, publicly disclosed, lost or stolen. We have measures in place that are designed to detect and respond to such security incidents and breaches of privacy and security mandates. Any such access, disclosure or other loss of information could result in legal claims or proceedings, liability under laws that protect the privacy of personal information, government enforcement actions and regulatory penalties. Unauthorized access, loss or dissemination could also disrupt our operations, including our ability to conduct research, development and commercialization activities, process and prepare company financial information, manage various selling, general and administrative aspects of our business and damage our reputation, in addition to possibly requiring substantial expenditures of resources to remedy, any of which could adversely affect our business. The loss of clinical trial data could result in delays in our regulatory approval efforts and significantly increase our costs to recover or reproduce the data. In addition, there can be no assurance that we will promptly detect any such disruption or security breach, if at all. To the extent that any disruption or security breach were to result in a loss of, or damage to, our data or applications, or inappropriate disclosure of confidential or proprietary information, we could incur liability and our research, development and commercialization efforts could be delayed.

Our ability to use our net operating losses to offset future taxable income may be subject to certain limitations.

Our net operating loss ("NOL") carryforwards could expire unused and be unavailable to offset future tax liabilities because of their limited duration or because of restrictions under U.S. tax law. As of December 31, 2022, we had U.S. federal and state NOLs of \$342.9 million and \$336.5 million, respectively. Our NOLs generated in tax years ending on or prior to December 31, 2017 are only permitted to be carried forward for 20 years under applicable U.S. tax law. Under the Tax Act, as modified by the CARES Act, our federal NOLs generated in tax years ending after December 31, 2017 may be carried forward indefinitely, but the deductibility of federal NOLs, particularly for tax years beginning after December 31, 2020, may be limited. It is uncertain if and to what extent various states will conform to the Tax Act and the CARES Act.

Section 382 of the Internal Revenue Code of 1986, as amended, or Section 382, contains rules that limit the ability of a company that undergoes an ownership change to utilize its net operating losses, or NOLs, and tax credits existing as of the date of such ownership change. Under the rules, such an ownership change is generally any change in ownership of more than 50% of a company's stock within a rolling three-year period. The rules generally operate by focusing on changes in ownership among stockholders considered by the rules as owning, directly or indirectly, 5% or more of the stock of a company and any change in ownership arising from new issuances of stock by the company. We have experienced multiple ownership changes since our inception and are conducting a study to assess whether an ownership change has occurred and whether these ownership changes will limit the future use of our NOL carryforwards. Future ownership changes as defined by Section 382 may further limit the amount of NOL carryforwards that could be utilized annually to offset future taxable income.

Our term loan contains restrictions that limit our flexibility in operating our business.

In October 2018, we entered into a loan and security agreement, as most recently amended and restated in January 2023, with Hercules, secured by a lien on substantially all of our assets, excluding intellectual property. This loan contains various covenants that limit our ability to engage in specified types of transactions. These covenants limit our ability to, among other things:

- sell, transfer, lease or dispose of certain assets;
- incur indebtedness;
- encumber or permit liens on certain assets;
- make certain investments;
- make certain restricted payments, including paying dividends on, or repurchasing or making distributions with respect to, our common stock; and
- enter into certain transactions with affiliates.

The covenants also include a requirement that we maintain cash in an aggregate amount greater than or equal to \$20 million; provided, however, that following the FDA approval of the sale and marketing of mavoxifafor for the treatment to patients with WHIM syndrome, the required level shall be reduced to \$10 million. Based on our current cash and cash equivalents and our current operating plan, we believe that if we fail to raise additional capital, we would be in violation of the minimum cash described above in the first quarter of 2024. A breach of any of the covenants under the loan and security agreement could result in a default under the loan. Upon the occurrence of an event of default under the loan, the lenders could elect to declare all amounts outstanding, if any, to be immediately due and payable and terminate all commitments to extend further credit. If there are any amounts outstanding that we are unable to repay, the lenders could proceed against the collateral granted to them to secure such indebtedness.

Our business could be adversely affected by economic downturns, inflation, increases in interest rates, natural disasters, public health crises such as the COVID-19 pandemic, political crises, geopolitical events, such as the war in Ukraine, or other macroeconomic conditions, which have in the past and may in the future negatively impact our business and financial performance. The global economy, including credit and financial markets, has experienced extreme volatility and disruptions, including, among other things, severely diminished liquidity and credit availability, declines in consumer confidence, declines in economic growth, supply chain shortages, increases in inflation rates, higher interest rates and uncertainty about economic stability. For example, the COVID-19 pandemic resulted in widespread unemployment, economic slowdown and extreme volatility in the capital markets. The U.S. Federal Reserve recently raised interest rates multiple times in response to concerns about inflation and it may raise them again. Higher interest rates, coupled with reduced government spending and volatility in financial markets may increase economic uncertainty. If the equity and credit markets deteriorate, including as a result of political unrest or war, such as the war in Ukraine, it may make any necessary debt or equity financing more difficult to obtain in a timely manner or on favorable terms, more costly or more dilutive. Increased inflation rates can adversely affect us by increasing our costs, including labor and employee benefit costs.

Risks Related to Ownership of Our Common Stock

Our stock price has been and is likely to continue to be volatile and fluctuate substantially.

The market price of our common stock has been and could continue to be subject to significant fluctuations. Market prices for securities of pharmaceutical, biotechnology and other life sciences companies have historically been particularly volatile. Some of the factors that may cause the market price of our common stock to fluctuate include:

- our ability or the ability of our collaborators to develop product candidates and conduct clinical trials that demonstrate such product candidates are safe and effective;
- our ability or the ability of our collaborators to obtain regulatory approvals for product candidates, and delays or failures to obtain such approvals;
- failure of any our product candidates to demonstrate safety and efficacy, receive regulatory approval and achieve commercial success;
- failure to maintain our existing third-party license, manufacturing and supply agreements;
- failure by us or our licensors to prosecute, maintain or enforce our intellectual property rights;
- changes in laws or regulations applicable to our current or future product candidates;
- any inability to obtain adequate supply of product candidates or the inability to do so at acceptable prices;
- adverse decisions by regulatory authorities;
- introduction of new or competing products by our competitors;
- failure to meet or exceed financial and development projections that we may provide to the public;
- the perception of the pharmaceutical industry by the public, legislatures, regulators and the investment community;
- announcements of significant acquisitions, strategic collaborations, joint ventures or capital commitments by us or our competitors;
- disputes or other developments relating to proprietary rights, including patents, litigation matters and our ability to obtain intellectual property protection for our technologies;
- additions or departures of key personnel;
- significant lawsuits, including intellectual property or stockholder litigation;

- announcements by us of material developments in our business, financial condition and/or operations;
- if securities or industry analysts do not publish research or reports about us, or if they issue an adverse or misleading opinions regarding our business and stock;
- changes in the market valuations of similar companies;
- general macroeconomic, political and market conditions and overall fluctuations in the financial markets in the United States and abroad;
- sales of our common stock or our stockholders in the future;
- trading volume of our common stock;
- adverse publicity relating to our markets generally, including with respect to other products and potential products in such markets;
- changes in the structure of health care payment systems;
- period-to-period fluctuations in our financial results; and
- the other factors described in this “Risk Factors” section and elsewhere in this Annual Report

In addition, companies trading in the stock market in general have experienced extreme price and volume fluctuations that have often been unrelated or disproportionate to the operating performance of these companies, including in connection with the ongoing COVID-19 pandemic, which has resulted in decreased stock prices for many companies notwithstanding the lack of a fundamental change in their underlying business models or prospects. Broad market and industry factors, including potentially worsening economic conditions and other adverse effects or developments relating to the ongoing COVID-19 pandemic, may negatively affect the market price of our common stock, regardless of our actual operating performance. In the past, following periods of volatility in the market price of a company’s securities, stockholders have often instituted class action securities litigation against those companies. Such litigation, if instituted, could result in substantial costs and diversion of management attention and resources, which could significantly harm our business, financial condition, results of operations and reputation.

“Penny stock” rules may make buying or selling our securities difficult which may make our stock less liquid and make it harder for investors to buy and sell our securities.

Trading in our securities is subject to the SEC’s “penny stock” rules and it is anticipated that trading in our securities will continue to be subject to the penny stock rules for the foreseeable future. The SEC has adopted regulations that generally define a penny stock to be any equity security that has a market price of less than \$5.00 per share, subject to certain exceptions. These rules require that any broker-dealer who recommends our securities to persons other than prior customers and accredited investors must, prior to the sale, make a special written suitability determination for the purchaser and receive the purchaser’s written agreement to execute the transaction. Unless an exception is available, the regulations require the delivery, prior to any transaction involving a penny stock, of a disclosure schedule explaining the penny stock market and the risks associated with trading in the penny stock market. In addition, broker-dealers must disclose commissions payable to both the broker-dealer and the registered representative and current quotations for the securities they offer. The additional burdens imposed upon broker-dealers by these requirements may discourage broker-dealers from recommending transactions in our securities, which could severely limit the liquidity of our securities and consequently adversely affect the market price for our securities.

If securities analysts do not publish research or reports about our business or if they publish negative evaluations of our stock, the price of our stock could decline.

The trading market for our common stock will be influenced, in part, on the research and reports that industry or financial analysts publish about us or our business. Equity research analysts may elect not to provide research coverage of our common stock, and such lack of research coverage may adversely affect the market price of our common stock. In the event we do have equity research analyst coverage, we will not have any control over the analysts or the content and opinions included in their reports. The price of our common stock could decline if one or more equity research analysts downgrade our stock or issue other unfavorable commentary or research. If one or more equity research analysts ceases coverage of us or fails to publish reports on us regularly, demand for our common stock could decrease, which in turn could cause our stock price or trading volume to decline.

We do not anticipate that we will pay any cash dividends in the foreseeable future.

The current expectation is that we will retain our future earnings to fund the development and growth of our business. In addition, the terms of our debt agreements may preclude us from paying dividends. As a result, capital appreciation, if any, of our common stock will be your sole source of gain, if any, for the foreseeable future. We are prohibited from declaring or paying any cash dividends under our existing loan and security agreement with Hercules.

Sales of a substantial number of shares of our common stock in the public market could cause our stock price to decline.

Sales of a substantial number of shares of our common stock in the public market, or the perception that these sales might occur, could depress the market price of our common stock and could impair our ability to raise capital through the sale of additional equity securities. We are unable to predict the effect that sales, particularly sales by our directors, executive officers, and significant stockholders, may have on the prevailing market price of our common stock.

In addition, we have filed registration statements on Form S-8 registering the issuance of shares of common stock subject to options or other equity awards issued or reserved for future issuance under our equity incentive plans. Shares registered under these registration statements are available for sale in the public market subject to vesting arrangements and exercise of options, as well as Rule 144 in the case of our affiliates.

If we fail to maintain an effective system of internal control over financial reporting, we may not be able to accurately report our financial results or prevent fraud. As a result, stockholders could lose confidence in our financial and other public reporting, which would harm our business and the trading price of our common stock.

We are subject to the reporting requirements of the Securities Exchange Act of 1934, as amended (the “Exchange Act”), the Sarbanes-Oxley Act of 2002 and the rules and regulations of The Nasdaq Stock Market (“Nasdaq”). Pursuant to Section 404 of the Sarbanes-Oxley Act of 2002 (“Section 404”), we are required to perform system and process evaluation and testing of our internal control over financial reporting to allow our management to report on the effectiveness of our internal control over financial reporting in this Annual Report.

Effective internal control over financial reporting is necessary for us to provide reliable financial reports and, together with adequate disclosure controls and procedures, is designed to prevent fraud. Any failure to implement required new or improved controls, or difficulties encountered in their implementation, could cause us to fail to meet our reporting obligations. In addition, any testing by us, as and when required, conducted in connection with Section 404, or any subsequent testing by our independent registered public accounting firm, as and when required, may reveal deficiencies in our internal control over financial reporting that are deemed to be significant deficiencies or material weaknesses or that may require prospective or retroactive changes to our consolidated financial statements or identify other areas for further attention or improvement. Inferior internal controls could also cause investors to lose confidence in our reported financial information, which could have a negative effect on the trading price of our common stock.

Pursuant to Section 404, we are required to furnish a report by our management on our internal control over financial reporting beginning with this Annual Report. However, while we remain a non-accelerated filer, we will not be required to include an attestation report on internal control over financial reporting issued by our independent registered public accounting firm. When we cease to be a smaller reporting company and no longer qualify as a non-accelerated filer, we will be required to incur substantial additional professional fees and internal costs to expand our accounting and finance functions in order to include such attestation report.

We may in the future discover weaknesses in our system of internal financial and accounting controls and procedures that could result in a material misstatement of our consolidated financial statements. Our internal control over financial reporting will not prevent or detect all error and all fraud. A control system, no matter how well designed and operated, can provide only reasonable, not absolute, assurance that the control system’s objectives will be met. Because of the inherent limitations in all control systems, no evaluation of controls can provide absolute assurance that misstatements due to error or fraud will not occur or that all control issues and instances of fraud will be detected. If we identify one or more material weaknesses in our internal controls, investors could lose confidence in the reliability of our consolidated financial statements, the market price of our stock could decline and we could be subject to sanctions or investigations by Nasdaq, the SEC or other regulatory authorities.

We are a “smaller reporting company” and cannot predict if the reduced reporting requirements applicable to smaller reporting companies will make our securities less attractive to investors.

We are a “smaller reporting company” under the Exchange Act as of June 30, 2022. We may continue to be a smaller reporting company if either (i) the market value of our common stock held by non-affiliates is less than \$250 million or (ii) our annual revenue was less than \$100.0 million during the most recently completed fiscal year and the market value of our common stock held by non-affiliates is less than \$700.0 million. As a smaller reporting company, we may rely on exemptions from certain disclosure requirements that are available to smaller reporting companies, including not being required to comply with the auditor attestation requirements of Section 404 of the Sarbanes-Oxley Act and reduced disclosure obligations regarding executive compensation in our periodic reports and proxy statements. For so long as we remain a smaller reporting company, we are permitted and intend to rely on such exemptions from certain disclosure and other requirements that are applicable to other public companies that are not smaller reporting companies.

We cannot predict if investors will find our securities less attractive because we may rely on the exemptions and reduced disclosure obligations applicable to smaller reporting companies. If some investors find our securities less attractive as a result, there may be a less active trading market for our common stock and our stock price may be more volatile.

We may become involved in securities class action litigation or shareholder derivative litigation that could divert management's attention and harm our business and insurance coverage may not be sufficient to cover all costs and damages.

In the past, securities class action or shareholder derivative litigation has often followed certain significant business transactions, such as the sale of a business division or announcement of a merger. This risk is especially relevant for us because biopharmaceutical companies have experienced significant stock price volatility in recent years. We may become involved in this type of litigation in the future. The outcome of litigation is necessarily uncertain, and we could be forced to expend significant resources in the defense of such suits, and we may not prevail. Monitoring and defending against legal actions is time-consuming for our management and detracts from management's ability to fully focus our internal resources on our business activities. In addition, we may incur substantial legal fees and costs in connection with any such litigation. We have not established any reserves for any potential liability relating to any such potential lawsuits. It is possible that we could, in the future, incur judgments or enter into settlements of claims for monetary damages. We currently maintain insurance coverage for some of these potential liabilities. Other potential liabilities may not be covered by insurance, insurers may dispute coverage or the amount of insurance may not be enough to cover damages awarded. In addition, certain types of damages may not be covered by insurance, and insurance coverage for all or certain forms of liability may become unavailable or prohibitively expensive in the future. A decision adverse to our interests on one or more legal matters or litigation could result in the payment of substantial damages, or possibly fines, and could have a material adverse effect on our reputation, financial condition and results of operations.

Provisions in our corporate charter documents and under Delaware law could make an acquisition of our company, which may be beneficial to our stockholders, more difficult and may prevent attempts by our stockholders to replace or remove our current management.

Provisions in our corporate charter and by-laws may discourage, delay or prevent a merger, acquisition or other change in control of our Company that stockholders may consider favorable, including transactions in which you might otherwise receive a premium for your shares. These provisions also could limit the price that investors might be willing to pay in the future for shares of our common stock, thereby depressing the market price of our common stock. In addition, because our board of directors is responsible for appointing the members of our management team, these provisions may frustrate or prevent any attempts by our stockholders to replace or remove our current management by making it more difficult for stockholders to replace members of our board of directors. Among other things, these provisions:

- establish a classified board of directors such that not all members of the board are elected at one time;
- allow the authorized number of our directors to be changed only by resolution of the board of directors;
- limit the manner in which stockholders can remove directors from the board;
- establish advance notice requirements for stockholder proposals that can be acted on at stockholder meetings and nominations to the board of directors;
- require that stockholder actions must be effected at a duly called stockholder meeting and prohibit actions by our stockholders by written consent;
- limit who may call stockholder meetings;
- authorize the board of directors to issue preferred stock without stockholder approval, which could be used to institute a shareholder rights plan, or so-called "poison pill," that would work to dilute the stock ownership of a potential hostile acquirer, effectively preventing acquisitions that have not been approved by the board of directors; and
- require the approval of the holders of at least 75% of the votes that all our stockholders would be entitled to cast to amend or repeal certain provisions of our charter or by-laws.

Moreover, because we are incorporated in Delaware, we are governed by the provisions of Section 203 of the Delaware General Corporation Law, which prohibits a person who owns in excess of 15% of our outstanding voting stock from merging or combining with the Company for a period of three years after the date of the transaction in which the person acquired in excess of 15% of our outstanding voting stock, unless the merger or combination is approved in a prescribed manner.

Our certificate of incorporation provides that the Court of Chancery of the State of Delaware will be the exclusive forum for substantially all disputes between the Company and our stockholders, which could limit our stockholders' ability to obtain a favorable judicial forum for disputes with the Company or our directors, officers, employees or stockholders.

Our certificate of incorporation provides that the Court of Chancery of the State of Delaware is the exclusive forum for any derivative action or proceeding brought on the Company's behalf, any action asserting a breach of fiduciary duty owed by our directors, officers, other employees or stockholders to the Company or our stockholders, any action asserting a claim against the Company arising pursuant to the Delaware General Corporation Law or as to which the Delaware General Corporation Law confers jurisdiction on the Court of Chancery of the State of Delaware, or any action asserting a claim arising pursuant to our certificate of incorporation or by-laws or governed by the internal affairs doctrine. This provision may limit a stockholder's ability to bring a claim in a judicial forum that it finds favorable for disputes with the Company or our directors, officers, employees or stockholders, which may discourage such lawsuits against the Company and our directors, officers, employees or stockholders.

Alternatively, if a court were to find this provision in our certificate of incorporation to be inapplicable or unenforceable in an action, we may incur additional costs associated with resolving such action in other jurisdictions, which could adversely affect our business and financial condition.

ITEM 1B. UNRESOLVED STAFF COMMENTS

None.

ITEM 2. PROPERTIES

We lease approximately 28,000 square feet of office space at 61 North Beacon Street, 4th Floor, Boston, Massachusetts, which serves as our corporate headquarters. The lease expires on November 30, 2026. The base monthly payment on the lease is approximately \$88.7 thousand as of December 31, 2022, subject to specified annual increases of approximately 3% during the term of the lease and not including operating expenses, certain utilities, taxes and insurance for which we are responsible. We have the right to sublease the premises, subject to landlord consent and we have the right to renew the lease for an additional five years at the then-prevailing effective market rental rate.

We lease approximately 1,200 square meters of laboratory and office space in Vienna, Austria under a lease that will expire in March 2028, with a monthly payment of approximately \$23.2 thousand.

ITEM 3. LEGAL PROCEEDINGS

From time to time, we may become involved in legal proceedings arising in the ordinary course of our business. We are not currently subject to any material legal proceedings.

ITEM 4. MINE SAFETY DISCLOSURES

Not applicable.

PART II

ITEM 5. MARKET FOR REGISTRANT'S COMMON EQUITY, RELATED STOCKHOLDER MATTERS AND ISSUER PURCHASES OF EQUITY SECURITIES

Market Information

Our common stock commenced trading on the Nasdaq Global Market under the symbol "ASNS" on November 16, 2017. Prior to that date, there was no public trading market for our common stock. On March 13, 2019, we completed a business combination in accordance with the terms of the Merger Agreement, by and among us, X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and the Merger Sub, pursuant to which, among other matters, Merger Sub merged with and into X4 Therapeutics, Inc., with X4 Therapeutics, Inc. continuing as our wholly-owned subsidiary and the surviving corporation of the merger. Following the Merger, on March 14, 2019, we effected a 1-for-6 reverse stock split of our common stock and changed our name to "X4 Pharmaceuticals, Inc." On March 13, 2019, following the completion of the Merger, our common stock began trading on the Nasdaq Capital Market under the symbol "XFOR".

Holders of Our Common Stock

As of March 1, 2023, there were 66 holders of record of our common stock, one of which is Cede & Co., a nominee for Depository Trust Company ("DTC"). All of the shares of common stock held by brokerage firms, banks and other financial institutions as nominees for beneficial owners are deposited into participant accounts at DTC, and are considered to be held of record by Cede & Co. as one stockholder.

Dividend Policy

We have never declared or paid cash dividends on our common stock. We currently intend to retain all available funds and any future earnings to fund the development and expansion of our business and we do not anticipate paying any cash dividends in the foreseeable future. Any future determination to declare and pay dividends will be made at the discretion of our board of directors and will depend on then-existing conditions, including our results of operations, financial condition, contractual restrictions, capital requirements, business prospects and other factors our board of directors may deem relevant.

Recent Sales of Unregistered Securities

None.

Purchase of Equity Securities by the Issuer and Affiliated Purchasers

None.

ITEM 6. [RESERVED]

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

You should read the following discussion and analysis of our financial condition and results of operations together with our consolidated financial statements and the related notes and the other financial information included elsewhere in this Annual Report. Some of the information contained in this discussion and analysis or set forth elsewhere in this Annual Report, including information with respect to our plans and strategy for our business and related financing, includes forward-looking statements that involve risks and uncertainties. As a result of many factors, including those factors set forth in the "Risk Factors" section of this Annual Report, our actual results could differ materially from the results described in or implied by these forward-looking statements.

For the discussion of the financial condition and results of operations for the year ended December 31, 2021 compared to the year ended December 31, 2020, refer to "Management's Discussion and Analysis of Financial Condition and Results of Operations" to our Annual Report on Form 10-K filed with the SEC on March 17, 2022.

Overview

We are a late clinical-stage biopharmaceutical company discovering and developing novel therapeutics for the treatment of rare diseases and those with limited treatment options, with a focus on conditions resulting from dysfunction of the immune system.

Our lead clinical candidate is mavorixafor, a small molecule antagonist of chemokine receptor CXCR4 that is being developed as an oral, once-daily therapy. Due to its ability to increase the mobilization of mature, functional white blood cells from the bone marrow into the bloodstream, we believe that mavorixafor has the potential to provide therapeutic benefit across a variety of chronic neutropenic disorders, including WHIM (Warts, Hypogammaglobulinemia, Infections, and Myelokathexis) syndrome, a rare, primary immunodeficiency.

Following announcement of positive top-line data from our global, pivotal, Phase 3 clinical trial, we are currently preparing a U.S. regulatory submission seeking approval of oral, once-daily mavorixafor in the treatment of people aged 12 years and older with WHIM syndrome. Submission is expected early in the second half of 2023.

We are also currently advancing mavorixafor in a Phase 2 clinical trial in people with certain chronic neutropenic disorders following positive results from a Phase 1b clinical trial of mavorixafor in people with idiopathic, cyclic or congenital neutropenia. Participants are now being enrolled in this Phase 2 clinical trial and we expect to provide an update on clinical results in the second or third quarter of 2023. We also expect to provide clarity on the scope and timing of our planned Phase 3 chronic neutropenia clinical program in the second or third quarter of 2023.

We believe that successfully developing mavorixafor and providing new therapeutic options to individuals in the U.S. diagnosed with certain chronic neutropenic disorders has the potential to revolutionize the treatment landscape, which is principally served by injectable therapies that are frequently associated with treatment-limiting adverse events.

To date, we have not generated revenue from product sales and do not expect to generate significant revenue from the sale of our products in the foreseeable future. If our development efforts for our product candidates are successful and result in regulatory approval, we may generate revenue in the future from product sales. We cannot predict if, when, or to what extent we will generate revenue from the commercialization and sale of our product candidates. We may never succeed in obtaining regulatory approval for any of our product candidates.

Our Pipeline

	CANDIDATE	INDICATION	PRECLINICAL	PHASE 1	PHASE 2	PHASE 3	NDA
In-House CHRONIC NEUTROPENIC DISORDERS	Mavorixafor	WHIM Syndrome (Warts, Hypogammaglobulinemia, Infections and Myelokathexis)	Phase 3 Complete				
		Idiopathic, Cyclic, and Congenital Chronic Neutropenia	Phase 2				
	X4P-003	Not yet disclosed					
Partnership ONCOLOGY	Mavorixafor	Waldenströms Macroglobulinemia* (double-mutation patients)	Phase 1b Complete				
	X4P-002	Oncology indications*	IND-enabling				

* Programs only being advanced through partnership

Macroeconomic Considerations

Unfavorable conditions in the economy in the United States and abroad may negatively affect the growth of our business and our results of operations. For example, macroeconomic events, including the COVID-19 pandemic, rising inflation, the U.S. Federal Reserve raising interest rates and the Russia-Ukraine war, have led to economic uncertainty globally. The effect of macroeconomic conditions may not be fully reflected in our results of operations until future periods. If, however, economic uncertainty increases or the global economy worsens, our business, financial condition and results of operations may be harmed. For further discussion of the potential impacts of macroeconomic events on our business, financial condition, and operating results, see the section titled "Risk Factors."

Results of Operations

Comparison of the Years Ended December 31, 2022 and 2021

The following table summarizes the results of our operations for the periods indicated:

	Year Ended December 31,		
	2022	2021	Change
	(in thousands)		
Operating expenses:			
Research and development	\$ 61,058	\$ 50,647	\$ 10,411
Selling, general and administrative	27,020	24,702	2,318
Gain on sale of non-financial asset	(509)	—	(509)
Impairment of goodwill	—	9,758	(9,758)
Total operating expenses	87,569	85,107	2,462
Loss from operations	(87,569)	(85,107)	(2,462)
Total other expense, net	(6,270)	(3,572)	(2,698)
Loss before provision for income taxes	(93,839)	(88,679)	(5,160)
Provision for income taxes	28	17	11
Net loss	\$ (93,867)	\$ (88,696)	\$ (5,171)

Research and Development Expenses

Research and development expenses consist primarily of costs incurred in connection with the discovery and development of our product candidates, including employee salaries and related expenses, expenses incurred in connection with the preclinical and clinical development of our product candidates, including under agreements with third parties, such as consultants and contract research organizations (“CROs”); the cost of manufacturing drug products for use in our preclinical studies and clinical trials, including under agreements with third parties, such as consultants and contract manufacturing organizations (“CMOs”); facilities, depreciation and other expenses, which include direct or allocated expenses for rent and maintenance of facilities and insurance; costs related to compliance with regulatory requirements; and payments made under third-party licensing agreements. We expense research and development costs as incurred.

	Year Ended December 31,		
	2022	2021	Change
(in thousands)			
Direct research and development expenses by product candidate:			
Mavoxifafor (X4P-001)	\$ 30,041	\$ 25,400	\$ 4,641
X4P-002	2,338	1,130	1,208
X4P-003	206	1,370	(1,164)
Unallocated expense	28,473	22,747	5,726
Total research and development expenses	\$ 61,058	\$ 50,647	\$ 10,411

Research and development expenses were \$61.1 million for the year ended December 31, 2022, as compared to \$50.6 million for the year ended December 31, 2021, reflecting an increase of \$10.4 million. The increase in research and development expenses in 2022 as compared to 2021 was primarily due to higher clinical trial expenses and third-party manufacturing costs related to mavoxifafor to support our ongoing clinical trials and increased consulting and professional services expenses related to these clinical trials. Research and development expenses also increased in 2022 due to an increase in unallocated expenses, primarily due to an increase in head count within our manufacturing, regulatory and clinical operations functions, resulting in higher compensation expenses, including stock-based compensation. In addition, unallocated research and development expense increased due to higher external regulatory compliance and information technology costs.

We expect that our research and development expenses, particularly for our mavoxifafor programs, will increase over the next several years as we continue to conduct our clinical trials of mavoxifafor in chronic neutropenic disorders. Research and development expenses related to our X4P-002 and X4P-003 programs were not significant in 2022 relative to our overall research and development expenses.

Selling, General and Administrative Expenses

Selling, general and administrative expenses consist primarily of salaries and related costs, including stock-based compensation for personnel in sale and marketing, executive, finance and administrative functions. Selling, general and administrative expenses also include direct and allocated facility-related costs, as well as professional fees for legal, patent, consulting, investor and public relations, accounting, and audit services.

Selling, general and administrative expenses were \$27.0 million in 2022, as compared to \$24.7 million in 2021, reflecting an increase of \$2.3 million. The increase in selling, general and administrative expenses in 2022 as compared to 2021 was primarily due to an increase in compensation, including stock-based compensation costs, primarily resulting from severance payments incurred during 2022 and increases in salaries. We expect selling, general and administrative expenses will grow in the future as we continue to build out our selling, general and administrative functions.

Goodwill Impairment

Goodwill is tested quantitatively for impairment at the reporting unit level annually in the fourth quarter, or more frequently when events or changes in circumstances indicate that the asset might be impaired. Examples of such events or circumstances include, but are not limited to, a significant adverse change in legal or business climate, an adverse regulatory action or unanticipated competition.

We have determined that our company operates in a single operating segment and has a single reporting unit. To perform the quantitative test, we compare the fair value of the reporting unit to its carrying value. As we have one reporting unit, we determine its fair value based on the market approach taking into consideration the market value of the company as a whole and any control premium that might be realized upon the sale of the reporting unit. If the fair value of the reporting unit exceeds the carrying value of its net assets, goodwill is not impaired, and no further testing is required. If the fair value of the reporting unit is less than the

carrying value, we measure the amount of impairment loss, if any, as the excess of the carrying value over the fair value of the reporting unit.

As of December 31, 2022 we determined that goodwill was not impaired based on its quantitative test. As of December 31, 2021, our market capitalization, measured as the price of our common stock multiplied by shares of common stock outstanding, dropped below the value of our net assets, including goodwill. As a result of the sustained decline in the market price of our common stock, the fair value of our single reporting unit, measured based on our market capitalization as of December 31, 2021, was lower than its carrying value and we concluded that goodwill was impaired. Accordingly, we recorded an impairment charge of \$9.8 million to reduce the carrying amount of goodwill to \$17.4 million as of December 31, 2021. Future declines in the market value of our common stock may result in additional impairment charges being recorded.

Gain on Sale of Non-Financial Asset

During the year ended December 31, 2022, a third party, who had previously acquired rights to certain intellectual property from us, terminated the arrangement and transferred these rights back us and we transferred these rights to another third party in return for \$0.5 million. We have no continuing involvement in any ongoing research and development activities associated with the intellectual property. We concluded that these third parties are "non-customers" as the underlying intellectual property transferred to and from these third parties supports potential drug candidates that are not aligned with our strategic focus and, therefore, are not an output of our ordinary activities. Accordingly, we classified this transaction as a "gain on sale of non-financial asset" for the year ended December 31, 2022. There was no such transaction in year ended December 31, 2021.

Other Expense, Net

	Year Ended December 31,		
	2022	2021	Change
	(in thousands)		
Interest income	\$ 219	\$ 10	\$ 209
Interest expense	(3,993)	(3,642)	(351)
Change in fair value of warrant and derivative liabilities	1,701	(366)	2,067
Research and development incentive program	534	789	(255)
Foreign currency losses, issuance costs related to warrants and other	(4,731)	(363)	(4,368)
Total other expense, net	\$ (6,270)	\$ (3,572)	\$ (2,698)

The increase in other expense, net, of \$2.7 million for the year ended December 31, 2022 as compared to 2021 was primarily due to an increase in transaction fees associated with the issuance of warrants that are accounted for as liabilities, partially offset by a decrease in the fair value of the embedded derivative liability associated with the Hercules Loan agreement, as defined below, and the net change in the fair value of warrants accounted for as liabilities, as further described in Note 10 to the consolidated financial statements included herein.

Income Taxes

For the years ended December 31, 2022, 2021 and 2020, we recorded an immaterial income tax provision related to our Austrian subsidiary. In addition, in 2020 we recorded tax expense related to a withholding tax related to a milestone payment received from a foreign jurisdiction. We do not expect to record a significant income tax benefit or expense for several years as we have significant net operating loss carryforwards that are fully reserved until such time as we begin to generate meaningful taxable income in our U.S. jurisdiction. We expect this will occur when and if we are able to commercialize our drug products in the future.

Liquidity and Capital Resources

Sources of Liquidity

To date, we have funded our operations primarily with proceeds from sales of common stock, warrants and prefunded warrants for the purchase of our preferred stock and our common stock, sales of preferred stock, proceeds from the issuance of convertible debt and borrowings under loan and security agreements.

ATM Sales Agreement — We have entered into a Controlled Equity OfferingSM Sales Agreement (“ATM Sales Agreement”), with B. Riley Securities, Inc., Cantor Fitzgerald & Co., and Stifel, Nicolaus & Company, Incorporated (collectively the “Sales Agents”), pursuant to which we may offer and sell, at our sole discretion through one or more of the Sales Agents, shares of our common stock having an aggregate offering price of up to \$50 million. To date, we have sold approximately \$14.3 million of our common stock, net of offering costs, under the ATM Sales Agreement.

LPC Agreement — In January 2022, we entered into an agreement, (the “LPC Agreement”) with Lincoln Park Capital Fund LLC (“Lincoln Park”), pursuant to which we have the right to sell to Lincoln Park shares of our common stock, having an aggregate value of up to \$50.0 million, subject to certain limitations and conditions, at our request during a 36-month period. The shares of common stock that we may sell under the LPC Agreement are capped at 5.6 million, which amount may be adjusted under certain conditions as defined in the LPC Agreement. In January 2022, we raised \$3.0 million from the sale of shares of our common stock through the LPC Agreement.

Public and Private Equity Offerings — Over the past several years we have funded our operations primarily from sales of common stock, warrants and prefunded warrants through both public offerings and private placements. In March 2021, we sold shares of common stock, redeemable common stock, and, in lieu of common stock, pre-funded warrants to purchase shares of common stock in a private placement for gross proceeds of \$55.0 million, before offering expenses and \$2 million paid for the subsequent settlement of redeemable common stock in August 2021. In November 2021, we raised approximately \$10.0 million through the sale of pre-funded warrants to an investor in a private placement. In March 2022, we sold shares of common stock and, in lieu of common stock, pre-funded warrants to purchase shares of common stock in a private placement for gross proceeds of \$3.0 million, before offering expenses. In June 2022, we sold shares of common stock and, in lieu of common stock, pre-funded warrants to purchase shares of common stock in a private placement for gross proceeds of \$55.7 million, before offering expenses. In December 2022, we sold shares of common stock and, in lieu of common stock, pre-funded warrants to purchase shares of common stock in a public offering for gross proceeds of \$65.1 million, before offering expenses.

Hercules Loan Agreement — In January 2023, we entered into a Second Amended and Restated Loan and Security Agreement (the “Hercules Loan Agreement”) with Hercules Capital, Inc., as agent and lender, and Hercules Capital Funding IV LLC and Hercules Capital Funding Trust 2022-1, as lenders (collectively, “Hercules”), which agreement amended and restated the Amended and Restated Loan and Security Agreement dated as of June 27, 2019, as subsequently amended from time to time (the “Previous Loan Agreement”). The Hercules Loan Agreement provides for a term loan of \$32.5 million and an interest-only payment period through October 1, 2024, provided however, if certain conditions are met, then the interest-only payment period will be extended to January 1, 2026. To date, we have borrowed the full \$32.5 million under the Hercules Loan Agreement, and such amount remains outstanding as of December 31, 2022.

Going Concern— Since our inception, we have incurred significant operating losses and negative cash flows from our operations. We have not yet commercialized any products and we do not expect to generate revenue from sales of any products for several years, if at all. As of December 31, 2022, our cash and cash equivalents were \$121.7 million and our restricted cash balance was \$1.3 million. We have a covenant under our Hercules Loan Agreement that currently requires that we maintain a minimum level of cash of \$20.0 million, subject to reduction to \$10 million upon the achievement of operational milestones. Based on our current financial projections and with no additional funding, we believe we will not be able to maintain the minimum cash required to satisfy this covenant beginning in the first quarter of 2024. In such event, the lenders could require the repayment of all outstanding debt.

Management has concluded that substantial doubt exists about our ability to continue as a going concern for the one-year period following the issuance of our consolidated financial statements for the year ended December 31, 2022. To finance our operations, we will need to raise additional capital, which cannot be assured. Unless and until we reach profitability in the future, we will require additional capital to fund our operations, which could be raised through a combination of equity offerings, debt financings, other third-party funding, marketing and distribution arrangements and other collaborations and strategic alliances. If we are unable to obtain funding, we could be forced to delay, reduce or eliminate some or all of our research and development programs, product portfolio expansion or commercialization efforts, which would adversely affect our business prospects, or we may be unable to continue operations.

Cash Flows

The following table summarizes our cash flow activities for each of the periods presented:

	Year Ended December 31,	
	2022	2021
	(in thousands)	
Net loss	\$ (93,867)	\$ (88,696)
Adjustments to reconcile net loss to net cash used in operating activities	11,029	19,289
Changes in operating assets and liabilities	5,736	(1,498)
Net cash used in operating activities	(77,102)	(70,905)
Net cash used in investing activities	(103)	(615)
Net cash provided by financing activities	117,230	74,245
Impact of foreign exchange on cash and restricted cash	(105)	(319)
Net increase in cash, cash equivalents and restricted cash	39,920	2,406
Cash, cash equivalents and restricted cash, beginning of period	83,108	80,702
Cash, cash equivalents and restricted cash, end of period	<u>\$ 123,028</u>	<u>\$ 83,108</u>

Operating Activities: During the year ended December 31, 2022, net cash used in operating activities was \$77.1 million, primarily resulting from our net losses of \$93.9 million, adjusted for noncash expenses of \$11.0 million and changes in our operating assets and liabilities of \$5.7 million. Noncash expenses primarily includes stock-based compensation expense of \$5.2 million. The change in operating assets and liabilities was primarily due to an increase in accounts payable and accrued expenses due to the timing of payments related to our CROs. Cash used in operating activities was higher for the year ended December 31, 2022 as compared to the prior year primarily due to higher net losses in the current year.

Investing Activities: During the years ended December 31, 2022 and 2021, cash used in investing activities of \$0.1 million, and \$0.6 million, respectively, primarily related to furniture and laboratory equipment purchases related to our research and development center in Vienna, Austria.

Financing Activities: During the year ended December 31, 2022, net cash provided by financing activities was \$117.2 million, consisting primarily of net proceeds from two private placements and a public offering of our common stock, warrants, and pre-funded warrants. During the year ended December 31, 2021, net cash provided by financing activities was \$74.2 million, consisting primarily of proceeds from the sale of our common stock and pre-funded warrants in a private placement.

Material Capital Requirements

Second Amended and Restated Loan and Security Agreement with Hercules

In October 2018, we entered into a Loan and Security Agreement, as subsequently amended from time to time, with Hercules. On January 6, 2023, we entered into the Hercules Loan Agreement, which amended and restated the previous loan and security agreement. Under the Hercules Loan Agreement, we have borrowed the maximum aggregate principal of \$32.5 million of the term loan. Borrowings under the Hercules Loan Agreement accrue interest at a variable rate equal to the greater of (i) 10.15%, or (ii) *The Wall Street Journal* prime rate plus 3.15%. In an event of default, and until such event is no longer continuing, the interest rate applicable to borrowings would be increased by 4.0%.

Borrowings under the Hercules Loan Agreement are repayable in monthly interest-only payments through September 2024, and in equal monthly payments of principal and accrued interest from October 1, 2024 until the maturity date of the loan on April 1, 2026. After the interest only-period, assuming no prepayments are made, principal payments of \$5.07 million will be due in 2024, \$21.6 million in 2025 and \$5.8 million in 2026. If certain conditions are met and we achieve certain operational and financial milestones, the maturity date will be extended to July 1, 2027 and the interest-only period will be extended to January 1, 2026. At our option, we may prepay all, but not less than all, of the outstanding borrowings, subject to a prepayment premium when such repayment is made. In connection with entering into the Hercules Loan Agreement on January 6, 2023, we settled \$1.3 million of end-of-term payment associated with the Previous Loan Agreement and we are required to pay end-of-term payments of

\$0.8 million and \$1.3 million on July 1, 2023 and April 1, 2026, respectively.

Borrowings under the Hercules Loan Agreement are secured by substantially all of our personal property and other assets except for our intellectual property (but including rights to payment and proceeds from the sale, licensing or disposition of the intellectual property). Our obligations under the agreement are subject to acceleration upon occurrence of specified events of default, including payment default, insolvency and a material adverse change in our business, operations or financial or other conditions. The Hercules Loan Agreement restricts our ability to incur additional indebtedness, pay dividends, encumber intellectual property, or engage in certain fundamental business transactions, such as mergers or acquisitions of other businesses, with certain exceptions.

Under the Hercules Loan Agreement, we have agreed to affirmative and negative covenants. The covenants include a requirement that we maintain cash in an account or accounts in which Hercules has a first priority security interest, in an aggregate amount greater than \$20.0 million. Upon the FDA approval of the sale and marketing of mavoxixafor for the treatment of patients with WHIM syndrome with a label claim that is generally consistent with that sought in our NDA filing, the required level shall be reduced to \$10.0 million. A breach of any of the covenants under the Hercules Loan Agreement could result in a default under the loan. Upon the occurrence of an event of default under the loan facility with Hercules, the lenders could elect to declare all amounts outstanding, if any, to be immediately due and payable and terminate all commitments to extend further credit. If there are any amounts outstanding that we are unable to repay, the lenders could proceed against the collateral granted to them to secure such indebtedness.

Lease Obligations

We have long-term lease obligations for office and laboratory space. Non-cancellable lease obligations are \$1.61 million in 2023, \$1.37 million in 2024, \$1.40 million in 2025, and \$1.66 million thereafter.

Funding Requirements

We believe that our cash and cash equivalents will allow us to fund operations into the second quarter of 2024. However, as noted above, based on our current financial projections we believe we would be in violation of a minimum cash covenant of the Hercules Loan Agreement with Hercules in the first quarter of 2024. In order to fund operations and satisfy the minimum cash covenant in the Hercules Loan Agreement, we will be required to raise additional capital, which may be through a combination of equity offerings, debt financings, other third-party funding, marketing and distribution arrangements and other collaborations and strategic alliances. During 2023 and beyond, assuming no changes to our current operational expectations, we expect our expenses to continue to increase in connection with our ongoing activities, particularly as we advance the current and anticipated clinical trials of our product candidates in development. Because of the numerous risks and uncertainties associated with research, development and commercialization of pharmaceutical product candidates, we are unable to estimate the exact amount of our funding requirements. Our short term and long term funding requirements will depend on and could increase significantly as a result of many factors, including:

- the scope, number, initiation, progress, timing, costs, design, duration, any potential delays, and results of clinical trials and nonclinical studies for our current or future product candidates, particularly our Phase 2 clinical trial of mavoxixafor for the treatment of patients with chronic neutropenic disorders;
- the outcome, timing and cost of regulatory reviews, approvals or other actions to meet regulatory requirements established by the FDA and comparable foreign regulatory authorities, including the potential for the FDA or comparable foreign regulatory authorities to require that we perform more studies for our product candidates than those that we currently expect;
- our ability to obtain marketing approval for our product candidates;
- the cost of filing, prosecuting, defending and enforcing our patent claims and other intellectual property rights covering our product candidates, including any such patent claims and intellectual property rights that we have licensed from Genzyme pursuant to the terms of our license agreement with Genzyme;
- our ability to maintain, expand and defend the scope of our intellectual property portfolio, including the cost of defending intellectual property disputes, including patent infringement actions brought by third parties against us or our product candidates;
- the cost and timing of completion of commercial-scale manufacturing activities with respect to our product candidates;

- our ability to establish and maintain licensing, collaboration or similar arrangements on favorable terms and whether and to what extent we retain development or commercialization responsibilities under any new licensing, collaboration or similar arrangement;
- the cost of establishing sales, marketing and distribution capabilities for any product candidates for which we may receive regulatory approval in regions where we choose to commercialize our products on our own;
- the success of any other business, product or technology that we acquire or in which we invest;
- the costs of acquiring, licensing or investing in businesses, product candidates and technologies;
- our need and ability to hire additional management and scientific and medical personnel;
- market acceptance of our product candidates, to the extent any are approved for commercial sale;
- the effect of competing technological and market developments; and
- the costs to operate as a public company

Until such time, if ever, as we can generate substantial product revenue, we expect to finance our cash needs through a combination of equity offerings, debt financings, collaborations, strategic alliances, and marketing, distribution or licensing arrangements with third parties. We have effective universal shelf registration statements on Form S-3 registering the sale of our common stock, warrants to purchase our common stock and other securities on terms that we may determine. We have an ATM Sales Agreement with the Sales Agents, pursuant to which we have offered to sell and continue to offer to sell, at our sole discretion through one or more of the Sales Agents, shares of our common stock. We have entered into a common stock purchase agreement with Lincoln Park Capital, pursuant to which Lincoln Park Capital has committed to purchase, at our request from time to time over a 36-month period, shares of our common stock having an aggregate offering price of up to \$50.0 million, of which \$3.0 million have been sold to date, subject to certain limitations.

To the extent that we raise additional capital through future equity offerings or debt financings, the ownership interest of our stockholders may be materially diluted, and the terms of such securities could include liquidation or other preferences that adversely affect the rights of our stockholders. Debt financing and preferred equity financing, if available, may involve agreements that include restrictive covenants that limit our ability to take specified actions, such as incurring additional debt, making capital expenditures or declaring dividends. If we raise additional funds through collaborations, strategic alliances or marketing, distribution or licensing arrangements with third parties, we may have to relinquish valuable rights to our technologies, future revenue streams, research programs or product candidates or grant licenses on terms that may not be favorable to us. If we are unable to raise additional funds through equity or debt financings or other arrangements when needed, we may be required to delay, reduce or eliminate our product development efforts or future commercialization efforts, or grant rights to develop and market product candidates that we would otherwise prefer to develop and market ourselves.

Critical Accounting Estimates

Our consolidated financial statements are prepared in accordance with generally accepted accounting principles in the United States. The preparation of our consolidated financial statements and related disclosures requires us to make estimates and judgments that affect the reported amounts of assets, liabilities, costs and expenses, and the disclosure of contingent assets and liabilities in our consolidated financial statements. We base our estimates on historical experience, known trends and events and various other factors that we believe are reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. We evaluate our estimates and assumptions on an ongoing basis. Our actual results may differ from these estimates under different assumptions or conditions.

While our significant accounting policies are described in more detail in Note 2 to our consolidated financial statements included elsewhere in this Annual Report, we believe that the following accounting policies are those most critical to the judgments and estimates used in the preparation of our consolidated financial statements.

Accrued Research and Development Expenses. As part of the process of preparing our consolidated financial statements, we are required to estimate our accrued research and development expenses. This process involves reviewing open contracts and purchase orders, communicating with our applicable personnel to identify services that have been performed on our behalf and estimating the level of service performed and the associated cost incurred for the service when we have not yet been invoiced or otherwise notified of actual costs. The majority of our service providers invoice us in arrears for services performed, on a pre-determined schedule or when contractual milestones are met; however, some require advance payments. We make estimates of our accrued expenses as of each balance sheet date in the consolidated financial statements based on facts and circumstances known to them at that time. For our significant vendors, we confirm the accuracy of these estimates with the service providers and make adjustments, if necessary. Examples of estimated accrued research and development expenses include fees paid to:

- vendors in connection with preclinical development activities;
- CROs and investigative sites in connection with preclinical studies and clinical trials; and
- CMOs in connection with the production of preclinical and clinical trial materials.

We base the expense recorded related to external research and development on our estimates of the services received and efforts expended pursuant to quotes and contracts with multiple CMOs and CROs that supply, conduct and manage preclinical studies and clinical trials on our behalf. The financial terms of these agreements are subject to negotiation, vary from contract to contract and may result in uneven payment flows. There may be instances in which payments made to our vendors will exceed the level of services provided and result in a prepayment of the expense. Payments under some of these contracts depend on factors such as the successful enrollment of patients and the completion of clinical trial milestones. In accruing service fees, we estimate the time period over which services will be performed and the level of effort to be expended in each period. If the actual timing of the performance of services or the level of effort varies from the estimate, we adjust the accrual or the amount of prepaid expenses accordingly.

Although we do not expect our estimates to be materially different from amounts actually incurred, our understanding of the status and timing of services performed relative to the actual status and timing of services performed may vary and may result in reporting amounts that are too high or too low in any particular period. To date, there have not been any material adjustments to our prior estimates of accrued research and development expenses.

Stock-Based Compensation. We measure all stock-based awards granted to employees, directors and consultants based on the grant-date fair value of the award and recognized compensation expense, net of estimated forfeitures, over the requisite service period, which is generally the vesting period of the respective award. The stock-based awards that we have issued to date include a service-based vesting condition and the expense for these awards is recognized using the straight-line method. We have also issued stock-based awards with performance-based vesting conditions that vest in part upon our achievement of operational milestones and over time thereafter for the subsequent two years as the employee continues to provide services. We assess the probability of achievement of these operational milestones and recognize stock-based compensation for these awards using the accelerated attribution model based on the fair value of the awards as of the date of grant and our best estimate of the date each operational milestone will be achieved. We update our estimates related to the probability and timing of achievement of the operational milestones each period until the award either vests or is forfeited.

The fair value of stock option grants is estimated on the date of grant using the Black-Scholes option-pricing model, which uses as inputs the fair value of our common stock and assumptions we make for the volatility of our common stock, the expected term of the stock options, the risk-free interest rate for a period that approximates the expected term of our stock options and an expected dividend yield. Prior to the closing of the Merger and the listing of our common stock on the Nasdaq Capital Market, our board of directors historically determined, as of the date of each option grant and with input from our management, the assistance of a third-party valuation specialist the estimated fair value of our common stock on the date of grant based on a number of objectives and subjective factors. Since the Merger and the listing of our common stock on the Nasdaq Capital Market, we have relied on the market price of our common stock to determine the fair value on the date of grant. As our common stock does not have a sufficient history of trading, we estimate our volatility based on the historical volatility of publicly traded peer companies. We estimate the expected term of our stock awards by utilizing the "simplified" method, which calculates the expected term based on weighted average midpoint of the award's vesting and expiration dates. We determine the risk-free interest rate by reference to the U.S. Treasury yield curve in effect at the time of grant of the award for time periods approximately equal to the expected term of the award. We estimate that no dividends will be paid as we do not expect to pay cash dividends in the foreseeable future.

The assumptions underlying these valuations represent the best estimates of our management, which involve inherent uncertainties and the application of our judgment. As a result, if factors or expected outcomes change and we use significantly different assumptions or estimates, the resulting share-based compensation expense could be materially different.

Goodwill. Business combinations are accounted for under the acquisition method. The total purchase price of an acquisition is allocated to the underlying identifiable net assets, based on their respective estimated fair values as of the acquisition date. Determining the fair value of assets acquired and liabilities assumed requires management's judgment and often involves the use of significant estimates and assumptions, including assumptions with respect to future cash inflows and outflows, probabilities of success, discount rates, and asset lives, among other items. Assets acquired and liabilities assumed are recorded at their estimated fair values. The excess of the purchase price over the estimated fair values of the net assets acquired is recorded as goodwill.

Goodwill is tested quantitatively for impairment at the reporting unit level annually in the fourth quarter, or more frequently when events or changes in circumstances indicate that the asset might be impaired. Examples of such events or circumstances include, but are not limited to, a significant adverse change in legal or business climate, an adverse regulatory action or unanticipated competition.

We have determined that we operate in a single operating segment and have a single reporting unit. To perform its quantitative test, we compare the fair value of our single reporting unit to the carrying value of its net assets, including goodwill. We use our market capitalization (common shares outstanding multiplied by the price per share of our common stock) to measure the fair value of the reporting unit. If the fair value of the reporting unit exceeds the carrying value of its net assets, goodwill is not impaired, and no further testing is required. If the fair value of the reporting unit is less than the carrying value, we measure the impairment loss as the excess of the carrying value over the fair value of the reporting unit. See Note 4 for more information on our goodwill impairment test as of December 31, 2022.

Smaller Reporting Company Status

We are a smaller reporting company as defined in the Exchange Act. We may take advantage of certain of the scaled disclosures available to smaller reporting companies and will be able to take advantage of these scaled disclosures for so long as (i) our voting and non-voting common stock held by non-affiliates is less than \$250.0 million measured on the last business day of our second fiscal quarter or (ii) our annual revenue is less than \$100.0 million during the most recently completed fiscal year and our voting and non-voting common stock held by non-affiliates is less than \$700.0 million measured on the last business day of our second fiscal quarter.

Recently Issued Accounting Pronouncements

A description of recently issued accounting pronouncements that may potentially impact our financial position and results of operations is disclosed in Note 2 to our consolidated financial statements appearing at the end of this Annual Report on Form 10-K.

ITEM 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK

As a smaller reporting company, we are not required to provide disclosure for this Item.

ITEM 8. FINANCIAL STATEMENTS AND SUPPLEMENTARY DATA

The financial statements required to be filed pursuant to this Item 8 are appended to this Annual Report.

The financial statements contain a Report of Independent Registered Public Accounting Firm PricewaterhouseCoopers LLP, Boston, Massachusetts, US (Firm ID 238).

An index of those financial statements is found in Item 15 of Part IV of this Annual Report.

ITEM 9. CHANGES IN AND DISAGREEMENTS WITH ACCOUNTANTS ON ACCOUNTING AND FINANCIAL DISCLOSURES

None.

ITEM 9A. CONTROLS AND PROCEDURES

Evaluation of Disclosure Controls and Procedures

We maintain “disclosure controls and procedures” as defined in Rules 13a-15(e) and 15d-15(e) under the Exchange Act, that are designed to ensure that information required to be disclosed in the reports we file and submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the SEC’s rules and forms. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by us in the reports we file or submit under the Exchange Act is accumulated and communicated to our management, including our principal executive officer and principal financial officer, as appropriate to allow timely decisions regarding required disclosure. In designing and evaluating our disclosure controls and procedures, management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives, and management necessarily applies its judgment in evaluating the benefits of possible controls and procedures relative to their costs.

Our management, with the participation of our Chief Executive Officer and Chief Financial Officer, who serve as our principal executive officer and principal financial officer, respectively, has evaluated the effectiveness of our disclosure controls and procedures as of December 31, 2022. Based on such evaluation, our Chief Executive Officer and Chief Financial Officer have concluded that our disclosure controls and procedures were effective at the reasonable assurance level.

Management’s Report on Internal Control Over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting for the company. Internal control over financial reporting is defined in Rules 13a-15(f) and 15d-15(f) promulgated under the Exchange Act as a process designed by, or under the supervision of, the company’s principal executive and principal financial officers and effected by the company’s board of directors, management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles and includes those policies and procedures that:

- pertain to the maintenance of records that in reasonable detail accurately and fairly reflect the transactions and dispositions of the assets of the company;
- provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and
- provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of the company’s assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Management conducted an assessment of our internal controls over financial reporting based on the framework established by the Committee of Sponsoring Organizations of the Treadway Commission in *Internal Control-Integrated Framework (2013)*. Based on the assessment, management concluded that, as of December 31, 2022, our internal control over financial reporting was effective.

This Annual Report does not include an attestation report of our registered public accounting firm regarding internal control over financial reporting due to an exemption provided to non-accelerated filers.

Changes in Internal Control over Financial Reporting

There have been no significant changes in our internal control over financial reporting (as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act) during the quarter ended December 31, 2022 that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

ITEM 9B. OTHER INFORMATION

None.

ITEM 9C. DISCLOSURE REGARDING FOREIGN JURISDICTIONS THAT PREVENT INSPECTIONS

Not applicable.

PART III

ITEM 10. DIRECTORS, EXECUTIVE OFFICERS AND CORPORATE GOVERNANCE

The information required by this Item is incorporated by reference to the information set forth in the sections titled “Proposal 1- Election of Directors,” “Information Regarding the Board of Directors and Corporate Governance” and “Executive Officers” in our 2023 Proxy Statement.

Information regarding our Code of Business Conduct and Ethics (the “Code of Conduct”) required by this item will be contained in our 2023 Proxy Statement under the caption “Information Regarding the Board of Directors and Corporate Governance – Code of Ethics,” and is hereby incorporated by reference. If we make any substantive amendments to the Code of Conduct or grant any waiver from a provision of the Code of Conduct to any executive officer or director, we will promptly disclose the nature of the amendment or waiver on our website. The full text of our Code of Conduct is available at the Investor Relations section of our website at investors.x4pharma.com/investor-relations. The reference to our website address does not constitute incorporation by reference of the information contained at or available through our website, and you should not consider it to be a part of this Annual Report on Form 10-K.

ITEM 11. EXECUTIVE COMPENSATION

The information required by this Item is incorporated by reference to the information set forth in the sections titled “Executive Compensation” in our 2023 Proxy Statement.

ITEM 12. SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT AND RELATED STOCKHOLDER MATTERS

The information required by this Item is incorporated by reference to the information set forth in the section titled “Security Ownership of Certain Beneficial Owners and Management” and “Equity Compensation Plan Information” in our 2023 Proxy Statement.

ITEM 13. CERTAIN RELATIONSHIPS AND RELATED TRANSACTIONS, AND DIRECTOR INDEPENDENCE

The information required by this Item is incorporated by reference to the information set forth in the section titled “Transactions with Related Persons and Indemnification” and “Information regarding the Board of Directors and Corporate Governance” in our 2023 Proxy Statement.

ITEM 14. PRINCIPAL ACCOUNTANT FEES AND SERVICES

The information required by this Item is incorporated by reference to the information set forth in the section titled “Principal Accountant Fees and Services” contained in our 2023 Proxy Statement.

PART IV

ITEM 15. EXHIBIT AND FINANCIAL STATEMENT SCHEDULES

(1) Financial Statements

The following documents are included on pages F-1 through F-36 attached hereto and are filed as part of this Annual Report.

	<u>Page</u>
Report of Independent Registered Public Accounting Firm PricewaterhouseCoopers LLP Boston, MA (Firm ID 238)	F-2
Consolidated Balance Sheets	F-3
Consolidated Statements of Operations and Comprehensive Loss	F-4
Consolidated Statements of Redeemable Common Stock and Stockholders' Equity	F-5
Consolidated Statements of Cash Flows	F-6
Notes to Consolidated Financial Statements	F-7

(2) Financial Statement Schedules:

All financial statement schedules have been omitted because they are not applicable, not required or the information required is shown in the consolidated financial statements or the notes thereto.

(3) Exhibits.

<u>Exhibit No.</u>	<u>Exhibit Description</u>	<u>Form</u>	<u>Exhibit</u>	<u>Date</u>	<u>Se File/ Ref No.</u>
3.1	Restated Certificate of Incorporation, as amended, as of September 1, 2022	8-K	3.1	9/1/2022	001-38295
3.2	Amended and Restated By-laws of the Company	8-K	3.2	11/20/2017	001-38295
4.1	Form of Common Stock Certificate	8-K	4.1	3/13/2019	001-38295
4.2	Form of Warrant to Purchase Common Stock of the Company (formerly Series A Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.)) issued to Silicon Valley Bank and Life Science Loans, LLC.	8-K	4.2	3/13/2019	001-38295
4.3	Form of Warrant to Purchase Common Stock of the Company (formerly Series A Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.)) issued to Maxim Partners LLC.	8-K	4.3	3/13/2019	001-38295
4.4	Form of Warrant to Purchase Common Stock of the Company (formerly Series B Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.)).	8-K	4.4	3/13/2019	001-38295
4.5	Form of Warrant to Purchase Common Stock of the Company (formerly Series B Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.)) issued to Hercules Capital, Inc.	8-K	4.5	3/13/2019	001-38295
4.6	Warrant Modification Agreement, dated as of December 11, 2018, with Hercules Capital, Inc.	8-K	4.6	3/13/2019	001-38295
4.7	Form of Prefunded Warrant.	8-K	4.1	04/12/2019	001-38295
4.8	Form of Class A Warrant	8-K	4.2	04/12/2019	001-38295
4.9	Form of Prefunded Warrant	8-K	4.1	11/29/2019	001-38295
4.10	Securities Purchase Agreement, dated March 18, 2021, by and among X4 Pharmaceuticals, Inc. and the persons party thereto.	8-K	10.1	3/19/2019	001-38295
4.11	Registration Rights Agreement, dated March 18, 2021, by and among X4 Pharmaceuticals, Inc. and the persons party thereto.	8-K	10.2	3/19/2019	001-38295

4.12	Form of March 2021 Prefunded Warrant	8-K	4.1	3/19/2019	001-38295
4.13	Securities Purchase Agreement, dated November 5, 2021, by and among X4 Pharmaceuticals, Inc. and the persons party thereto.	8-K	10.1	11/5/2021	001-38295
4.14	Registration Rights Agreement, dated November 5, 2021, by and among X4 Pharmaceuticals, Inc. and the persons party thereto.	8-K	10.2	11/5/2021	001-38295
4.15	Form of November 2021 Prefunded Warrant	8-K	4.1	11/5/2021	001-38295
4.16	Controlled Equity OfferingSM Sales Agreement, dated as of August 7, 2020, by and between X4 Pharmaceuticals, Inc. and B. Riley Securities, Inc., Cantor Fitzgerald & Co. and Stifel, Nicolaus & Company, Incorporated.	S-3	1.2	8/7/2020	001-38295
4.17*	Description of Registered Securities				
4.18	Form of March 2022 Prefunded Warrant	8-K	4.1	3/3/2022	001-38295
4.19	Securities Purchase Agreement, dated March 3, 2022, by and among X4 Pharmaceuticals, Inc. and the persons party thereto.	8-K	10.1	3/3/2022	001-38295
4.20	Registration Rights Agreement, dated March 3, 2022, by and among X4 Pharmaceuticals, Inc. and the persons party thereto.	8-K	10.2	3/3/2022	001-38295
4.21	Purchase Agreement, dated as of January 14, 2022, by and between X4 Pharmaceuticals, Inc. and Lincoln Park Capital Fund, LLC.	8-K	10.1	1/14/2022	001-38295
4.22	Registration Rights Agreement, dated as of January 14, 2022, by and between X4 Pharmaceuticals, Inc. and Lincoln Park Capital Fund, LLC.	8-K	10.2	1/14/2022	001-38295
4.23	Securities Purchase Agreement, dated June 30, 2022, by and among X4 Pharmaceuticals Inc. and the persons party thereto.	8-K	10.1	7/1/2022	001-38295
4.24	Registration Rights Agreement, dated June 30, 2022, by and among X4 Pharmaceuticals Inc. and the persons party thereto.	8-K	10.2	7/1/2022	001-38295
4.25	Form of July 2022 Pre-Funded Warrant	8-K	4.1	7/1/2022	001-38295
4.26	Form of July 2022 Warrant	8-K	4.2	7/1/2022	001-38295
4.27	Form of December 2022 Pre-Funded Warrant	8-K	4.1	12/9/2022	001-38295
4.28	Form of Class C Warrant.	8-K	4.2	12/9/2022	001-38295
10.1@	2015 Employee, Director and Consultant Equity Incentive Plan, as amended.	8-K	10.1.1	3/13/2019	001-38295
10.2@	Form of Stock Option Agreement under the 2015 Employee, Director and Consultant Equity Incentive Plan, as amended.	8-K	10.1.2	4/2/2019	001-38295
10.3@	Form of Restricted Stock Unit Agreement under the 2015 Employee, Director and Consultant Equity Incentive Plan, as amended	8-K	10.6	6/17/2019	001-38295
10.4@	Amended and Restated 2017 Equity Incentive Plan	S-8	99.1	6/10/2020	333-239082
10.5@	Form of Incentive Stock Option Agreement under the 2017 Equity Incentive Plan	S-1	10.8	10/20/2017	001-38295
10.6@	Form of Nonstatutory Stock Option Agreement under the 2017 Equity Incentive Plan	S-1	10.9	10/20/2017	001-38295
10.7@	Form of Restricted Stock Agreement under the 2017 Equity Incentive Plan	8-K	10.6	11/27/2018	001-38295
10.8@	Form of Restricted Stock Unit Agreement under the 2017 Equity Incentive Plan	8-K	10.5	6/19/2019	001-38295
10.9@	Form of Performance-Based Restricted Stock Unit	S-8	99.6	6/10/2020	333-239082
10.10@	2017 Employee Stock Purchase Plan	S-1	10.10	10/20/2017	001-38295
10.11@	X4 Pharmaceuticals, Inc. 2019 Inducement Equity Incentive Plan	8-K	10.1	12/23/2022	001-38295

10.12@	Form of Stock Option Agreement under the 2019 Inducement Equity Incentive Plan	8-K	10.2	6/17/2019	001-38295
10.13@	Form of Restricted Stock Agreement under the 2019 Inducement Equity Incentive Plan	8-K	10.3	6/17/2019	001-38295
10.14@	Form of Restricted Stock Unit Agreement under the 2019 Inducement Equity Incentive Plan	8-K	10.4	6/17/2019	001-38295
10.15@	Form of Indemnification Agreement (for directors and executive officers)	S-1/A	10.36	11/06/2017	001-38295
10.16@*	Director Compensation Policy				
10.17@	Amended and Restated Executive Employment Agreement, dated as of March 13, 2019, by and between the Company and Paula Ragan, Ph.D.	8-K	10.3	3/13/2019	001-38295
10.18@	Amendment to Amended and Restated Executive Employment Agreement, dated as of March 13, 2019, dated February 13, 2020 by and between the Company and Paula Ragan, Ph.D.	10-Q	10.1	3/31/2020	001-38295
10.19@	Second Amended and Restated Executive Employment Agreement, dated as of March 7, 2022 by and between the Company and Adam S. Mostafa.	10-K	10.19	3/17/2022	001-38295
10.20@	Amended and Restated Executive Employment Agreement, dated as of March 7, 2022 by and between the Company and Mary DiBiase	10-K	10.23	3/17/2022	001-38295
10.21@*	Executive Employment Agreement, dated as of November 14, 2022, by and between the Company and Murray Stewart				
10.22#	License Agreement, dated as of July 10, 2014, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, LLC) and Genzyme Corp., a Sanofi company.	8-K	10.5#	3/13/2019	001-38295
10.23#	Amendment No. 1 to License Agreement, dated as of October 23, 2014, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Genzyme Corporation, a Sanofi company.	8-K/A	10.6#	5/13/2019	001-38295
10.24#	License Agreement, dated as of December 13, 2016, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Georgetown University.	8-K/A	10.7#	5/13/2019	001-38295
10.25#	Exclusive License Agreement, dated as of December 23, 2016, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Beth Israel Deaconess Medical Center.	8-K/A	10.8#	5/13/2019	001-38295
10.26	License Agreement, dated as of November 13, 2020, by and between X4 Pharmaceuticals Inc. and the Dana Farber Cancer Institute.	10-K	10.33	3/19/2021	001-38295
10.27*+	Second Amended and Restated Loan and Security Agreement, dated as of January 6, 2023, by and among X4 Pharmaceuticals, Inc., X4 Therapeutics, Inc., Hercules Capital, Inc. and Hercules Capital Funding IV LLC and Hercules Capital Funding Trust 2022-1				
10.28	Lease, dated as of November 11, 2019, by and between X4 Pharmaceuticals Inc. and Beacon North Village, LLC.	10-K	10.32	3/12/2020	001-38295
10.29	Settlement Agreement, dated as of March 8, 2019, by and among X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc.), Artemis AC Corp., X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.), Arsanis Biosciences GmbH and Österreichische Forschungsförderungsgesellschaft GmbH.	8-K	10.1	4/11/2019	001-38295
10.30	Master Services Agreement, dated September 10, 2015, by and between X4 Pharmaceuticals Inc. and Mayne Pharma Inc. (formerly known as Metrics, Inc.)	10-K	10.35	3/12/2020	001-38295
10.31	Amendment No. 1 to Master Services Agreement, dated August 25, 2017, by and between X4 Pharmaceuticals Inc. and Mayne Pharma Inc. (formerly known as Metrics, Inc.)	10-K	10.36	3/12/2020	001-38295

10.32	Amendment No. 2 to Master Services Agreement, dated February 28, 2020, by and between X4 Pharmaceuticals Inc. and Mayne Pharma Inc.	10-K	10.37	3/12/2020	001-38295
10.33	Master Services Agreement, dated February 19, 2016, by and between X4 Pharmaceuticals Inc. and Aptuit (Oxford) Limited	10-K	10.38	3/12/2020	001-38295
10.34	Amendment No. 1 to Master Services Agreement, dated February 19, 2016, by and between X4 Pharmaceuticals Inc. and Aptuit (Oxford) Limited	10-K	10.39	3/12/2020	001-38295
10.35	Amendment No. 2 to Master Services Agreement, dated February 19, 2021, by and between X4 Pharmaceuticals Inc. and Aptuit (Oxford) Limited	10-K	10.48	3/19/2021	001-38295
10.36@	Form of Stock Appreciation Right Agreement under the X4 Pharmaceuticals, Inc. Amended and Restated 2017 Equity Incentive Plan	8-K	10.1	11/9/2022	001-38295
21.1	List of Subsidiaries	10-K	21.1	3/17/2022	001-38295
23.1*	Consent of PricewaterhouseCoopers LLP, Independent Registered Public Accounting Firm				
31.1*	Certification of the Chief Executive Officer, as required by Section 302 of the Sarbanes-Oxley Act of 2002				
31.2*	Certification of the Chief Financial Officer, as required by Section 302 of the Sarbanes-Oxley Act of 2002				
32.1**	Certification of the Chief Executive Officer and Chief Financial Officer, as required by Section 906 of the Sarbanes-Oxley Act of 2002				
101.INS	XBRL Instance Document				
101.SCH	XBRL Taxonomy Extension Schema Document				
101.CAL	XBRL Taxonomy Extension Calculation Linkbase Document				
101.DEF	XBRL Taxonomy Extension Definition Linkbase Document				
101.LAB	XBRL Taxonomy Extension Label Linkbase Document				
101.PRE	XBRL Taxonomy Extension Presentation Linkbase Document				
104	Cover Page Interactive Data File (formatted as Inline XBRL)				

* Filed herewith

** Furnished and not filed herewith

Certain confidential portions of this Exhibit were omitted by means of marking such portions with brackets (“[***]”) because the identified confidential portions (i) are not material and (ii) is the type of information that the Registrant treats as private or confidential.

+ Certain schedules and exhibits have been omitted from this Exhibit pursuant to Item 601(a)(5) of Regulation S-K. The Registrant will furnish a copy of any omitted schedule or exhibit to the U.S. Securities and Exchange Commission or its staff upon request.

@ Indicates management contract or compensatory plan

The agreements and other documents filed as exhibits to this Annual Report on Form 10-K are not intended to provide factual information or other disclosure other than with respect to the terms of the agreements or other documents themselves, and you should not rely on them for that purpose. In particular, any representations and warranties made by us in these agreements or other documents were made solely within the specific context of the relevant agreement or document and may not describe the actual state of affairs as of the date they were made or at any other time.

ITEM 16. FORM 10-K SUMMARY

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

X4 PHARMACEUTICALS, INC.

Date: March 21, 2023

By: /s/ Paula Ragan
Paula Ragan, Ph.D.
President and Chief Executive Officer

Pursuant to the requirements of the Securities Exchange Act of 1934, as amended, this report has been signed by the following persons on behalf of the Registrant and in the capacities and on the dates indicated.

<u>Signature</u>	<u>Title</u>	<u>Date</u>
<u>/s/ Paula Ragan</u> Paula Ragan, Ph.D.	President, Chief Executive Officer and Director <i>(Principal Executive Officer)</i>	March 21, 2023
<u>/s/ Adam S. Mostafa</u> Adam S. Mostafa	Chief Financial Officer and Treasurer <i>(Principal Financial Officer and Principal Accounting Officer)</i>	March 21, 2023
<u>/s/ Michael S. Wyzga</u> Michael S. Wyzga	Chairman of the Board of Directors	March 21, 2023
<u>/s/ William Aliski</u> William E. Aliski	Director	March 21, 2023
<u>/s/ Gary J. Bridger</u> Gary J. Bridger, Ph.D.	Director	March 21, 2023
<u>/s/ Francoise De Craecker</u> Francoise De Craecker	Director	March 21, 2023
<u>/s/ Alison Lawton</u> Alison F. Lawton	Director	March 21, 2023
<u>/s/ David McGirr</u> David McGirr	Director	March 21, 2023
<u>/s/ Murray W. Stewart</u> Murray W. Stewart, M.D.	Director	March 21, 2023

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Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of X4 Pharmaceuticals, Inc.

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheets of X4 Pharmaceuticals, Inc. and its subsidiaries (the "Company") as of December 31, 2022 and 2021, and the related consolidated statements of operations and comprehensive loss, of redeemable common stock and stockholders' equity and of cash flows for each of the three years in the period ended December 31, 2022, including the related notes (collectively referred to as the "consolidated financial statements"). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2022 and 2021, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2022 in conformity with accounting principles generally accepted in the United States of America.

Substantial Doubt about the Company's Ability to Continue as a Going Concern

The accompanying consolidated financial statements have been prepared assuming that the Company will continue as a going concern. As discussed in Note 1 to the consolidated financial statements, the Company has incurred operating losses and negative cash flows from operations since inception, that raise substantial doubt about its ability to continue as a going concern. Management's plans in regard to these matters are also described in Note 1. The consolidated financial statements do not include any adjustments that might result from the outcome of this uncertainty.

Basis for Opinion

These consolidated financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's consolidated financial statements based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits of these consolidated financial statements in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud. The Company is not required to have, nor were we engaged to perform, an audit of its internal control over financial reporting. As part of our audits we are required to obtain an understanding of internal control over financial reporting but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control over financial reporting. Accordingly, we express no such opinion.

Our audits included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. We believe that our audits provide a reasonable basis for our opinion.

Critical Audit Matters

The critical audit matter communicated below is a matter arising from the current period audit of the consolidated financial statements that was communicated or required to be communicated to the audit committee and that (i) relates to accounts or disclosures that are material to the consolidated financial statements and (ii) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing a separate opinion on the critical audit matter or on the accounts or disclosures to which it relates.

External Research and Development Costs

As described in Note 2 to the consolidated financial statements, costs associated with internal research and development and external research and development services, including drug development and preclinical studies, are expensed as incurred. The Company's research and development expense for the year ended December 31, 2022 was \$61.1 million, a portion of which relates to external research and development costs. Management recognizes external research and development costs based on an evaluation of the progress to completion of specific tasks using information provided to the Company by its service providers. As disclosed by management, this process involves reviewing open contracts and purchase orders, communicating with applicable personnel to identify services that have been performed, and estimating the level of service performed and the associated cost incurred for the service when the Company has not yet been invoiced or otherwise notified of actual costs.

The principal consideration for our determination that performing procedures relating to external research and development costs is a critical audit matter is a high degree of auditor effort in performing procedures related to the Company's external research and development costs.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the consolidated financial statements. These procedures included, among others, testing external research and development costs on a sample basis, which included tracing relevant information to the underlying contract research organization and contract manufacturing organization agreements, purchase orders, invoices received, and information received from certain third party service providers, where applicable.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
March 21, 2023

We have served as the Company's auditor since 2016.

X4 PHARMACEUTICALS INC.
CONSOLIDATED BALANCE SHEETS
(In thousands, except share and per share amounts)

	December 31, 2022	December 31, 2021
Assets		
Current assets:		
Cash and cash equivalents	\$ 121,718	\$ 81,787
Research and development incentive receivable	1,152	747
Prepaid expenses and other current assets	5,807	5,344
Total current assets	128,677	87,878
Property and equipment, net	1,104	1,514
Goodwill	17,351	17,351
Right-of-use assets	7,229	8,710
Other assets	1,225	1,723
Total assets	\$ 155,586	\$ 117,176
Liabilities and Stockholders' Equity		
Current liabilities:		
Accounts payable	\$ 7,777	\$ 4,283
Accrued expenses	12,034	7,870
Current portion of lease liability	1,198	1,075
Current portion of long-term debt	1,315	795
Total current liabilities	22,324	14,023
Long-term debt, including accretion, net of discount	32,304	33,139
Lease liabilities	3,603	4,776
Warrant liability (Note 4)	23,131	—
Other liabilities	173	826
Total liabilities	81,535	52,764
Commitments and contingencies (Note 9)		
Stockholders' equity:		
Common stock, \$0.001 par value. 500,000,000 and 125,000,000 shares authorized as of December 31, 2022 and December 31, 2021, respectively; 121,667,250 and 28,127,657 shares issued and outstanding as of December 31, 2022 and December 31, 2021, respectively	122	28
Additional paid-in capital	450,786	347,374
Accumulated other comprehensive loss	(119)	(119)
Accumulated deficit	(376,738)	(282,871)
Total stockholders' equity	74,051	64,412
Total liabilities and stockholders' equity	\$ 155,586	\$ 117,176

The accompanying notes are an integral part of these consolidated financial statements

X4 PHARMACEUTICALS, INC.
CONSOLIDATED STATEMENTS OF OPERATIONS AND COMPREHENSIVE LOSS
(In thousands, except per share amounts)

	Year Ended December 31,		
	2022	2021	2020
License revenue	\$ —	\$ —	\$ 3,000
Operating expenses:			
Research and development	61,058	50,647	41,932
Selling, general and administrative	27,020	24,702	20,942
Goodwill impairment	—	9,758	—
Gain on sale of nonfinancial assets	(509)	—	—
Total operating expenses	<u>87,569</u>	<u>85,107</u>	<u>62,874</u>
Loss from operations	(87,569)	(85,107)	(59,874)
Other income (expense):			
Interest income	219	10	273
Interest expense	(3,993)	(3,642)	(2,688)
Change in fair value of warrant and derivative liabilities	1,701	(366)	(437)
Loss on extinguishment of debt	—	—	(162)
Other income (expense)	(4,197)	426	905
Total other expense, net	<u>(6,270)</u>	<u>(3,572)</u>	<u>(2,109)</u>
Loss before provision for income taxes	(93,839)	(88,679)	(61,983)
Provision for income taxes	28	17	148
Net loss and comprehensive loss	(93,867)	(88,696)	(62,131)
Deemed dividend on Class B Warrant price reset	(2,546)	(13,943)	—
Net loss attributable to common stockholders	<u>\$ (96,413)</u>	<u>\$ (102,639)</u>	<u>\$ (62,131)</u>
Net loss per share attributable to common stockholders—basic and diluted	<u>\$ (1.52)</u>	<u>\$ (3.99)</u>	<u>\$ (3.09)</u>
Weighted average shares of common stock outstanding—basic and diluted	63,526	25,749	20,077

The accompanying notes are an integral part of these consolidated financial statements.

X4 PHARMACEUTICALS, INC.

CONSOLIDATED STATEMENTS OF REDEEMABLE COMMON STOCK AND STOCKHOLDERS' EQUITY

(In thousands, except share amounts)

	Redeemable Common Stock		Common Stock		Additional Paid-In Capital	Accumulated Other Comprehensive Income (Loss)	Accumulated Deficit	Total Stockholders' Equity
	Shares	Amount	Shares	Amount				
Balance at December 31, 2019	—	—	16,128,862	\$ 16	\$ 261,367	\$ (119)	\$ (132,044)	\$ 129,220
Exercise of stock options			17,689	—	127			127
Stock-based compensation expense					5,428			5,428
Issuance of shares under employee stock purchase plan			26,643		169			169
Vesting of restricted stock units, less shares withheld and retired to satisfy tax obligations			132,537		(14)			(14)
Net loss							(62,131)	(62,131)
Balance at December 31, 2020			16,305,731	16	267,077	(119)	(194,175)	72,799
Issuance of common stock, redeemable common stock and pre-funded warrants for the purchase of common stock, net of issuance costs of \$4.4 million	229,885	1,875	9,435,951	10	73,858			73,868
Issuance of common stock under employee stock purchase plan			45,816		219			219
Exercise of stock options			5,860		40			40
Exercise of pre-funded warrants			2,129,768	2				2
Vesting of restricted stock units			204,531					—
Repurchase and retirement of redeemable common stock	(229,885)	(1,875)						—
Stock-based compensation					6,180			6,180
Net loss							(88,696)	(88,696)
Balance at December 31, 2021	—	—	28,127,657	28	347,374	(119)	(282,871)	64,412
Issuance of common stock, warrants and prefunded warrants for the purchase of common stock, net of issuance costs of \$4.7 million			92,461,988	92	59,270			59,362
Vesting of restricted stock units, less shares withheld and retired to satisfy tax obligations			372,831	—	(13)			(13)
Exercise of warrants and prefunded warrants			499,871	1				1
Stock-based compensation expense					5,199			5,199
Issuance of shares of common stock under employee stock purchase plan			204,903	1	202			203
Reclassification of warrant liability to equity (Note 10)					38,754			38,754
Net loss							(93,867)	(93,867)
Balance at December 31, 2022			121,667,250	\$ 122	\$ 450,786	\$ (119)	\$ (376,738)	\$ 74,051

The accompanying notes are an integral part of these consolidated financial statements

X4 PHARMACEUTICALS, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In thousands)

	Year Ended December 31,		
	2022	2021	2020
Cash flows from operating activities:			
Net loss	\$ (93,867)	\$ (88,696)	\$ (62,131)
Adjustments to reconcile net loss to net cash used in operating activities:			
Stock-based compensation expense	5,199	6,180	5,428
Depreciation and amortization expense	513	499	351
Goodwill impairment	—	9,758	—
Non-cash lease expense	1,481	1,393	879
Accretion of debt discount	918	756	532
Loss on extinguishment of debt	—	—	162
Change in fair value of warrant and derivative liability	2,881	366	437
Other	37	337	(413)
Changes in operating assets and liabilities:			
Prepaid expenses, other current assets and research and development incentive receivable	(610)	(1,755)	(1,655)
Accounts payable	3,425	1,166	1,031
Accrued expenses	3,803	(152)	1,517
Operating lease liabilities	(882)	(698)	(1,067)
Operating lease right-of-use asset, net of non-cash portion	—	(59)	(3,889)
Net cash used in operating activities	<u>(77,102)</u>	<u>(70,905)</u>	<u>(58,818)</u>
Cash flows from investing activities:			
Purchase of property, equipment and intangible assets	(103)	(615)	(1,362)
Net cash used in investing activities	<u>(103)</u>	<u>(615)</u>	<u>(1,362)</u>
Cash flows from financing activities:			
Proceeds from exercise of stock options, warrants and pre-funded warrants and issuance of shares of common stock under employee stock purchase plans	208	260	561
Issuance costs related to sale of warrants for the purchase of common stock accounted for as a liability and amendments to loan and security agreement (Note 10)	(4,802)	—	—
Employee taxes paid related to net share settlement of vested restricted stock units	(12)	—	(278)
Proceeds from borrowings under loan and security agreements, net of issuance costs	—	—	12,388
Repayments of borrowings under loan and security agreement	(795)	—	—
Proceeds from sale of shares of common stock, redeemable common stock, warrants and pre-funded warrants, net of issuance costs	122,631	75,985	(277)
Settlement and retirement of redeemable common stock	—	(2,000)	—
Net cash provided by financing activities	<u>117,230</u>	<u>74,245</u>	<u>12,394</u>
Effect of exchange rate changes on cash, cash equivalents and restricted cash	(105)	(319)	402
Net increase (decrease) in cash, cash equivalents and restricted cash	<u>39,920</u>	<u>2,406</u>	<u>(47,384)</u>
Cash, cash equivalents and restricted cash at beginning of period	83,108	80,702	128,086
Cash, cash equivalents and restricted cash at end of period	<u>\$ 123,028</u>	<u>\$ 83,108</u>	<u>\$ 80,702</u>
Supplemental disclosure of cash flow information			
Cash paid for interest	\$ 3,006	\$ 2,906	\$ 2,099
Supplemental disclosure of non-cash investing and financing activities:			
Acquisition of property, equipment and right-of-use assets included in accounts payable	\$ —	\$ —	\$ 54
Acquisition of right-of-use assets financed by lease liabilities	\$ —	\$ 1,343	\$ —
Issuance costs not yet paid	\$ 661	\$ 24	\$ —

The accompanying notes are an integral part of these consolidated financial statements.

X4 PHARMACEUTICALS, INC.
NOTES TO CONDENSED CONSOLIDATED FINANCIAL STATEMENTS
(Unaudited)

1. NATURE OF THE BUSINESS AND BASIS OF PRESENTATION

X4 Pharmaceuticals, Inc. (together with its subsidiaries, the “Company”) is a late-stage clinical biopharmaceutical company focused on the research and development of novel therapeutics for the treatment of rare diseases and those with limited treatment options, with a focus on conditions resulting from dysfunction of the immune system. The Company’s lead clinical candidate is mavorixafor, a small molecule antagonist of the chemokine receptor CXCR4 that is being developed as an oral, once-daily therapy. Due to its ability to increase the mobilization of mature, functional white blood cells from the bone marrow into the bloodstream, the Company believes that mavorixafor has the potential to provide therapeutic benefit across a variety of chronic neutropenic disorders, including WHIM (Warts, Hypogammaglobulinemia, Infections, and Myelokathexis (“WHIM”)) syndrome, a rare, primary immunodeficiency, and certain cancers. Following announcement of positive top-line data from the Company’s global, pivotal, Phase 3 clinical trial in November 2022, the Company is preparing a United States regulatory submission seeking approval of oral, once-daily mavorixafor in the treatment of people aged 12 years and older with WHIM syndrome. The Company is also currently enrolling participants in a Phase 2 clinical trial in people with certain chronic neutropenic disorders following positive results from a Phase 1b clinical trial evaluating mavorixafor in people with idiopathic, cyclic, or congenital neutropenia that were presented in the third quarter of 2022. The Company also conducted a proof-of-concept Phase 1b clinical trial of mavorixafor in combination with ibrutinib in people with Waldenström’s macroglobulinemia (“Waldenström’s”), a rare form of lymphoma. The Company reported positive results from the Waldenström’s Phase 1b trial in the third quarter of 2022 and concluded the trial in December 2022. Any further studies of mavorixafor in Waldenström’s or other oncology indication will be subject to completing a strategic partnership. The Company is headquartered in Boston, Massachusetts and has an additional facility in Vienna, Austria.

Going Concern Assessment—In accordance with Accounting Standards Update (“ASU”) No. 2014-15, *Disclosure of Uncertainties about an Entity’s Ability to Continue as a Going Concern (Subtopic 205-40)* (“ASU 2014-15”), the Company has evaluated whether there are certain conditions and events, considered in the aggregate, that raise substantial doubt about the Company’s ability to continue as a going concern within one year after the date that the consolidated financial statements are issued. Since inception, the Company has incurred significant operating losses and negative cash flows from operations. As of December 31, 2022, the Company had \$121.7 million of cash and cash equivalents, an accumulated deficit of \$376.7 million, net loss of \$93.9 million and net cash used in operating activities of \$77.1 million. The Company has a covenant under its Second Amended and Restated Loan and Security Agreement with Hercules Capital Inc. that requires that the Company maintain a minimum level of cash of \$20 million, subject to reduction to \$10 million upon the achievement of operational milestones. Based on its current cash flow projections and with no additional funding, the Company believes it will not be able to maintain the minimum cash required to satisfy this covenant beginning in the first quarter of 2024. In such event, the lender could require the repayment of all outstanding debt.

Management has assessed the Company’s ability to continue as a going concern in accordance with the requirements of ASC 205-40 and determined that the Company’s accumulated deficit, history of losses and future expected losses met the ASC 205-40 standard for raising substantial doubt about the Company’s ability to continue as a going concern. The Company does not have adequate financial resources to fund its forecasted operating costs for at least one year after the date that these consolidated financial statements are issued. The accompanying consolidated financial statements do not include any adjustments relating to the recoverability and classification of recorded asset amounts or the amounts and classification of liabilities that might result from the outcome of this uncertainty. Accordingly, the consolidated financial statements have been prepared on a basis that assumes the Company will continue as a going concern and which contemplates the realization of assets and satisfaction of liabilities and commitments in the ordinary course of business.

To finance its operations, the Company will need to raise additional capital, which cannot be assured. Unless and until the Company reach’s profitability in the future, it will require additional capital to fund our operations, which could be raised through a combination of equity offerings, debt financings, other third-party funding, marketing and distribution arrangements and other collaborations and strategic alliances. If the Company is unable to obtain funding, it could be forced to delay, reduce or eliminate some or all of its research and development programs, product portfolio expansion or commercialization efforts, which would adversely affect its business prospects, or it may be unable to continue operations.

Principles of Consolidation— The consolidated financial statements include the accounts of the Company and its wholly-owned subsidiaries, including X4 Pharmaceuticals (Austria) GmbH (“X4 Austria”), which is incorporated in Vienna, Austria, and X4 Therapeutics, Inc. All significant intercompany accounts and transactions have been eliminated.

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2. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Use of Estimates— The preparation of the Company’s consolidated financial statements in conformity with U.S. Generally Accepted Accounting Principles (“GAAP”) requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the consolidated financial statements, and the reported amounts of expenses during the reporting period. Significant estimates and assumptions reflected in these consolidated financial statements include, but are not limited to, the accrual of research and development expenses, the impairment or lack of impairment of long-lived assets including operating lease right-of-use assets and goodwill, and the constraint of variable consideration from contracts with customers. The Company bases its estimates on historical experience, known trends and other market-specific or other relevant factors that it believes to be reasonable under the circumstances. On an ongoing basis, management evaluates its estimates when there are changes in circumstances, facts and experience. Changes in estimates are recorded in the period in which they become known. As of the date of issuance of these consolidated financial statements, the Company is not aware of any specific event or circumstance that would require the Company to update its estimates, assumptions and judgments or revise the carrying value of its assets or liabilities. Actual results could differ from those estimates, and any such differences may be material to the Company’s consolidated financial statements.

Foreign Currency and Currency Translation— The functional currency of the Company’s foreign subsidiary, X4 Austria, is the U.S. dollar. However, X4 Austria maintains its books and records in Euro. As a result, monetary assets and liabilities are translated at current exchange rates as of the balance sheet date, non-monetary assets such as property and equipment and equity accounts are translated at historic rates and income and expenses are translated at the average exchanges rates for the period. Adjustments resulting from the translation of the consolidated financial statements of X4 Austria into U.S. dollars are included in the determination of net loss and are recorded in other expense, net.

Concentrations of Credit Risk and Significant Suppliers— Financial instruments that potentially subject the Company to concentrations of credit risk consist principally of cash and cash equivalents and research and development incentive receivables. The Company generally maintains cash balances in various operating accounts at financial institutions that management believes to be of high credit quality in amounts that may exceed federally insured limits. The Company has not experienced losses related to its cash and cash equivalents.

The Company is dependent on third-party manufacturers to supply products for research and development activities in its programs. The Company relies and expects to continue to rely on a small number of manufacturers to supply it with its requirements for the active pharmaceutical ingredients and formulated drugs related to these programs. These programs could be adversely affected by a significant interruption in these manufacturing services or in the supply of active pharmaceutical ingredients and formulated drugs.

Cash and Cash Equivalents— The Company considers all highly liquid investments with maturities of three months or less at the date of purchase to be cash equivalents. Cash equivalents consisted of money market funds as of December 31, 2022 and 2021.

Restricted Cash

<i>(in thousands)</i>	As of December 31, 2022	As of December 31, 2021
Letter of credit security: Waltham lease	\$ 250	\$ 250
Letter of credit security: Vienna Austria lease	205	216
Letter of credit security: Boston lease	855	855
Total restricted cash	\$ 1,310	\$ 1,321
Restricted cash included in prepaid expenses and other current assets	\$ 285	\$ —
Restricted cash included in other assets	\$ 1,025	\$ 1,321

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In connection with the Company's lease agreement for its facilities in Massachusetts and Austria, the Company maintains letters of credit, which are secured by restricted cash, for the benefit of the respective landlord. In accordance with the Company's Second Amended and Restated Loan and Security Agreement with Hercules and as further described in Note 7, the Company at all times must maintain a minimum level of cash of \$20.0 million in an account or accounts in which Hercules has a first priority security interest as further described in Note 7.

The following table provides a reconciliation of cash, cash equivalents, and restricted cash reported within the consolidated balance sheets to the sum to the total of amounts shown in the Company's consolidated statements of cash flows as of December 31, 2022, 2021 and 2020:

<i>(in thousands)</i>	December 31, 2022	December 31, 2021	December 31, 2020
Cash and cash equivalents	\$ 121,718	\$ 81,787	\$ 78,708
Restricted cash, current (included within prepaid expenses and other current assets)	285	—	264
Restricted cash, non-current (included within other assets)	1,025	1,321	1,730
Total cash, cash equivalents and restricted cash	\$ 123,028	\$ 83,108	\$ 80,702

Property and Equipment— Property and equipment are stated at cost less accumulated depreciation and amortization. Depreciation and amortization expense is recognized using the straight-line method over the estimated useful life of each asset, as follows:

	Estimated Useful Life
Office furniture	3 to 7 years
Computer equipment	3 years
Laboratory equipment	3 to 10 years
Leasehold improvements	Shorter of lease term or 10 years

Estimated useful lives are periodically assessed to determine if changes are appropriate. Maintenance and repairs are charged to expense as incurred. When assets are retired or otherwise disposed of, the cost of these assets and related accumulated depreciation or amortization are eliminated from the consolidated balance sheet and any resulting gains or losses are included in the consolidated statements of operations and comprehensive loss in the period of disposal. Costs for capital assets not yet placed into service are capitalized as construction-in-progress and depreciated once placed into service.

Right-of-Use Assets and Leases— The Company accounts for leases in accordance with Accounting Standards Codification ("ASC"), Topic 842, *Leases* ("ASC 842"). Under ASC 842, at the inception of an arrangement, the Company determines whether the arrangement contains a lease based on the unique facts and circumstances present. Leases with a non-cancellable term greater than one year are recognized on the balance sheet as right-of-use assets with associated current and non-current lease liabilities. The Company has elected not to recognize on the balance sheet leases with terms of one year or less. Options to renew a lease are not included in the Company's initial lease term assessment unless there is reasonable certainty that the Company will renew the lease. If a lease is cancellable without penalty, the Company excludes from the lease term periods following the cancellation notice period unless it is reasonably certain that the Company will not cancel the lease.

Operating lease liabilities and their corresponding right-of-use assets are recorded based on the present value of lease payments over the expected remaining lease term. Certain adjustments to the right-of-use operating asset may be required for items such as incentives received or accrued rent. The interest rate implicit in lease contracts is typically not readily determinable. As a result, the Company utilizes its incremental borrowing rates, which are the rates it incurs to borrow on a collateralized basis over a similar term an amount equal to the lease payments in a similar economic environment. The Company has referenced the effective rate of its Hercules borrowings, as adjusted for differences terms, to determine calculate its incremental borrowing rate for each of its operating leases.

In accordance with the guidance in ASC 842, components of a lease are split into lease components and non-lease components. A policy election is available pursuant to which an entity may elect to not separate lease and non-lease components. Rather, each lease component and the related non-lease components are accounted for together as a single component. For new and amended leases beginning in 2019 and after, the Company has elected to account for the lease and non-lease components as a combined

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lease component for its office and laboratory building leases.

Impairment of Long-Lived Assets— Long-lived assets consist of property and equipment and operating lease right-of-use assets. Long-lived assets to be held and used are tested for recoverability whenever events or changes in business circumstances indicate that the carrying amount of the assets may not be fully recoverable. Factors that the Company considers in deciding when to perform an impairment review include significant underperformance of the business in relation to expectations, significant negative industry or economic trends and significant changes or planned changes in the use of the assets. If an impairment review is performed to evaluate a long-lived asset group for recoverability, the Company compares forecasts of undiscounted cash flows expected to result from the use and eventual disposition of the long-lived asset group to its carrying value. An impairment loss would be recognized in loss from operations when estimated undiscounted future cash flows expected to result from the use of an asset group are less than its carrying amount. The impairment loss would be based on the excess of the carrying value of the impaired asset group over its fair value. To date, the Company has not recorded any material impairment losses on long-lived assets.

Goodwill— Business combinations are accounted for under the acquisition method. The total purchase price of an acquisition is allocated to the underlying identifiable net assets, based on their respective estimated fair values as of the acquisition date. Determining the fair value of assets acquired and liabilities assumed requires management's judgment and often involves the use of significant estimates and assumptions, including assumptions with respect to future cash inflows and outflows, probabilities of success, discount rates, and asset lives, among other items. Assets acquired and liabilities assumed are recorded at their estimated fair values. The excess of the purchase price over the estimated fair values of the net assets acquired is recorded as goodwill.

Goodwill is tested quantitatively for impairment at the reporting unit level annually in the fourth quarter, or more frequently when events or changes in circumstances indicate that the asset might be impaired. Examples of such events or circumstances include, but are not limited to, a significant adverse change in legal or business climate, an adverse regulatory action, a significant decline in the price of the Company's common stock, or unanticipated competition.

The Company has determined that it operates in a single operating segment and has a single reporting unit. To perform its quantitative test, the Company compares the fair value of the reporting unit to its carrying value. If the fair value of the reporting unit exceeds the carrying value of its net assets, goodwill is not impaired, and no further testing is required. If the fair value of the reporting unit is less than the carrying value, the Company measures the amount of impairment loss, if any, as the excess of the carrying value over the fair value of the reporting unit. See Note 4 for more information on the Company's goodwill impairment tests as of December 31, 2022 and 2021.

Fair Value Measurements— Certain assets and liabilities of the Company are carried at fair value under GAAP. Fair value is defined as the exchange price that would be received for an asset or paid to transfer a liability (an exit price) in the principal or most advantageous market for the asset or liability in an orderly transaction between market participants on the measurement date. Valuation techniques used to measure fair value must maximize the use of observable inputs and minimize the use of unobservable inputs. Financial assets and liabilities carried at fair value are to be classified and disclosed in one of the following three levels of the fair value hierarchy, of which the first two are considered observable and the last is considered unobservable:

- Level 1—Quoted prices in active markets for identical assets or liabilities.
- Level 2—Observable inputs (other than Level 1 quoted prices), such as quoted prices in active markets for similar assets or liabilities, quoted prices in markets that are not active for identical or similar assets or liabilities, or other inputs that are observable or can be corroborated by observable market data.
- Level 3—Unobservable inputs that are supported by little or no market activity that are significant to determining the fair value of the assets or liabilities, including pricing models, discounted cash flow methodologies and similar techniques.

The embedded derivative liability related to the redemption features of the Company's debt with Hercules as described further below is carried at fair value and is a Level 3 measurement. The Company's cash equivalents, consisting of money market funds invested in U.S. Treasury securities, are carried at fair value, determined based on Level 1 and Level 2 inputs in the fair value hierarchy described above. The carrying values of the Company's accounts payable and accrued expenses approximate their fair values due to the short-term nature of these liabilities. The carrying value of the Company's outstanding loan and security agreement with Hercules approximates its fair value at December 31, 2022 because the debt bears interest at a variable market rate and the Company's credit risk has not materially changed since the inception of the agreement.

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Segment Information— The Company manages its operations as a single operating segment for the purposes of assessing performance and making operating decisions. The Company’s focus is on the research, development and commercialization of novel therapeutics for the treatment of rare diseases.

Revenue Recognition— The Company records revenue, if any, using the guidance of ASC Topic 606, *Revenue from Contracts with Customers* (“ASC 606”), as amended. The Company’s revenues to date have been generated through a license agreement with Abbisko Therapeutics Co., Ltd. (“Abbisko”). For collaboration arrangements, the Company first determines which elements of the arrangement are deemed to be within the scope of ASC Topic 808 *Collaborative Arrangements* (“ASC 808”) and those that are more reflective of a vendor-customer relationship and, therefore, within the scope of ASC 606. The Company’s policy is generally to recognize amounts received from collaborators in connection with joint operating activities that are within the scope of ASC 808 as a reduction in research and development expense. To date, there have been no transactions within the scope of ASC 808.

Upon the potential approval of the sales and marketing of the Company’s lead product candidate, revenue related to its sale and distribution will be accounted for under ASC 606. The Company recognizes revenue when its customers obtain control of promised goods or services, in an amount that reflects the consideration which the Company determines it expects to receive in exchange for those goods or services. To determine revenue recognition for arrangements that the Company determines are within the scope of ASC 606, the Company performs the following five steps: (1) identify the customer and contract(s) with a the customer; (2) identify the performance obligation(s) in the contract; (3) determine the transaction price, adjusted for variable consideration resulting from potential returns, rebates and down-stream charges; (4) allocate the transaction price to the performance obligation(s) in the contract; and (5) recognize revenue when (or as) the Company satisfies its performance obligation(s), which is expected to be upon shipment of the finished product (labelled bottles of capsulized drug product).

As part of the accounting for these arrangements, the Company must make significant judgments, including the estimation of the amount of variable consideration to include in the transaction price.

Once a contract is determined to be within the scope of ASC 606, the Company assesses the goods or services promised within the contract and determines those that are performance obligations. Arrangements that include rights to additional goods or services that are exercisable at a customer’s discretion are generally considered options. The Company assesses if these options provide a material right to the customer and if so, they are considered performance obligations.

The Company assesses whether each promised good or service is distinct for the purpose of identifying the performance obligations in the contract. This assessment involves subjective determinations and requires management to make judgments about the individual promised goods or services and whether such are separable from the other aspects of the contractual relationship. Promised goods and services are considered distinct provided that:

- i. the customer can benefit from the good or service either on its own or together with other resources that are readily available to the customer (that is, the good or service is capable of being distinct) and
- ii. the entity’s promise to transfer the good or service to the customer is separately identifiable from other promises in the contract (that is, the promise to transfer the good or service is distinct within the context of the contract).

In assessing whether a promised good or service is distinct, the Company considers factors such as the research, manufacturing and commercialization capabilities of the customer and the availability of the associated expertise in the general marketplace. The Company also considers the intended benefit of the contract in assessing whether a promised good or service is separately identifiable from other promises in the contract. If a promised good or service is not distinct, an entity is required to combine that good or service with other promised goods or services until it identifies a bundle of goods or services that is distinct.

The transaction price is then determined and allocated to the identified performance obligations in proportion to their standalone selling prices (“SSP”) on a relative SSP basis. SSP is determined at contract inception and is not updated to reflect changes between contract inception and when the performance obligations are satisfied. Determining the SSP for performance obligations requires significant judgment. In developing the SSP for a performance obligation, the Company considers applicable market conditions and relevant entity-specific factors, including factors that were contemplated in negotiating the agreement with the customer and estimated costs. The Company validates the SSP for performance obligations by evaluating whether changes in the key assumptions used to determine the SSP will have a significant effect on the allocation of arrangement consideration between multiple performance obligations.

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If the consideration promised in a contract includes a variable amount, the Company estimates the amount of consideration to which it will be entitled in exchange for transferring the promised goods or services to a customer. The Company determines the amount of variable consideration by using either the expected value method or the most-likely-amount method. The Company includes the unconstrained amount of estimated variable consideration in the transaction price. The amount included in the transaction price reflects the amount for which it is probable that a significant reversal of cumulative revenue recognized will not occur. At the end of each subsequent reporting period, the Company re-evaluates the estimated variable consideration included in the transaction price and any related constraint, and if necessary, adjusts its estimate of the overall transaction price. Any such adjustments are recorded on a cumulative catch-up basis in the period of adjustment.

The Company then recognizes as revenue the amount of the transaction price that is allocated to the respective performance obligation when (or as) each performance obligation is satisfied at a point in time or over time, and if over time based on the use of an output or input method.

At the inception of each arrangement that includes non-refundable payments for contingent milestones, particularly in license agreements, the Company evaluates whether the milestones are considered probable of being achieved and estimates the amount to be included in the transaction price using the most-likely-amount method. If it is probable that a significant revenue reversal would not occur, the associated milestone value is included in the transaction price. Milestone payments that are not within the control of the Company or the licensee, such as regulatory approvals, are not considered probable of being achieved until those approvals are received. At the end of each reporting period, the Company re-evaluates the probability of the achievement of contingent milestones and the likelihood of a significant reversal of such milestone revenue, and if necessary, adjusts its estimate of the overall transaction price. Any such adjustments are recorded on a cumulative catch-up basis, which would affect licensing revenue in the period of adjustment. This quarterly assessment may result in the recognition of revenue related to a contingent milestone payment before the milestone event has been achieved.

Research and Development Programs— Proceeds under the research and development incentive program from the Austrian government are recognized as other income in an amount equal to the qualifying expenses incurred in each period multiplied by the applicable reimbursement percentage. Incentive income recognized upon incurring qualifying expenses in advance of receipt of proceeds from research and development incentives is recorded in the consolidated balance sheet as research and development incentive receivable.

Research and Development Costs— Costs associated with internal research and development and external research and development services, including drug development and preclinical studies, are expensed as incurred. Research and development expenses include costs for salaries, employee benefits, subcontractors, facility-related expenses, depreciation and amortization, stock-based compensation, third-party license fees, laboratory supplies, and external costs of outside vendors engaged to conduct discovery, preclinical and clinical development activities and clinical trials as well as to manufacture clinical trial materials, and other costs. The Company recognizes external research and development costs based on an evaluation of the progress to completion of specific tasks using information provided to the Company by its service providers.

Nonrefundable advance payments for services to be received in the future for use in research and development activities are recorded as prepaid expenses. Such prepaid expenses are recognized as an expense when the related services have been performed, or when it is no longer expected that the goods will be delivered or the services rendered.

Patent Costs— All patent-related costs incurred in connection with filing and prosecuting patent applications are expensed as incurred due to the uncertainty about the recovery of the expenditure. Amounts incurred are classified as selling, general and administrative expenses.

Debt Issuance Costs— Debt issuance costs consist of payments made to secure commitments under certain debt financing arrangements. These amounts are recognized as interest expense over the period of the financing arrangement using the effective interest method. If the financing arrangement is canceled or forfeited, or if the utility of the arrangement to the Company is otherwise compromised, these costs are recognized as interest expense immediately. The Company's consolidated financial statements present debt issuance costs related to a recognized debt liability as a direct reduction from the carrying amount of that debt liability.

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Stock-Based Compensation— The Company measures all stock-based awards granted to employees, nonemployees and directors based on the fair value on the date of the grant and recognizes compensation expense for those awards, net of estimated forfeitures, over the requisite service period, which is generally the vesting period of the respective award. The Company issues stock-based awards with service-based vesting conditions and records the expense for these awards using the straight-line method. The Company has also issued stock-based awards with performance-based vesting conditions that vest in part upon the Company's achievement of operational milestones and over time thereafter for the subsequent two years as the employee continues to provide services. The Company assesses the probability of achievement of these operational milestones and recognizes stock-based compensation for these awards using the accelerated attribution model based on the fair value of the awards as of the date of grant and its best estimate of the date each operational milestone will be achieved.

The Company classifies stock-based compensation expense in its consolidated statements of operations and comprehensive loss in the same manner in which the award recipient's payroll costs are classified or in which the award recipient's service payments are classified.

The Company recognizes compensation expense for only the portion of awards that are expected to vest. In developing a forfeiture rate estimate, the Company has considered its historical experience to estimate pre-vesting forfeitures for service-based awards. The impact of a forfeiture rate adjustment is recognized in full in the period of adjustment, and if the actual forfeiture rate is materially different from the Company's estimate, the Company may be required to record adjustments to stock-based compensation expense in future periods.

The fair value of each stock option grant is estimated on the date of grant using the Black-Scholes option-pricing model. Prior to March 13, 2019, the Company was a private company and lacked company-specific historical and implied volatility information for its common stock. Therefore, the Company estimates its expected common stock price volatility based on the historical volatility of publicly traded peer companies and expects to continue to do so until it has adequate historical data regarding the volatility of its own traded stock price. The expected term of the Company's stock options has been determined utilizing the "simplified" method for awards that qualify as "plain-vanilla" options. The expected term of stock options granted to non-employee consultants is equal to the contractual term of the option award. The risk-free interest rate is determined by reference to the U.S. Treasury yield curve in effect at the time of grant of the award for time periods approximately equal to the expected term of the award. Expected dividend yield considers the fact that the Company has never paid cash dividends on common stock and does not expect to pay any cash dividends in the foreseeable future.

Derivative Liabilities: Hercules Loan Redemption Feature— The Company's loan agreement with Hercules (see Note 7) contains a redemption feature that, upon an event of default, provides Hercules the option to accelerate and demand repayment of the debt, including a prepayment premium, or, at its election, charge additional contingent interest fees on any overdue interest or principal payments. The redemption feature meets the definition of a derivative instrument as the repayment of the debt contains a substantial premium, resulting in the redemption feature not being clearly and closely related to its host instrument. Accordingly, the Company classifies this derivative as a liability within other liabilities (non-current) on its consolidated balance sheets. The derivative liability was initially recorded at fair value on the date of the Hercules Loan Agreement and is subsequently remeasured to fair value at each reporting date. Changes in the fair value of this derivative liability, which is included in other liabilities, are recognized as a component of other income (expense), net in the consolidated statement of operations and comprehensive loss. Changes in the fair value of this derivative liability will continue to be recognized until all amounts outstanding under the Hercules Loan Agreement are repaid or until the Hercules Loan Agreement is terminated.

Comprehensive Loss— For the year ended December 31, 2022, 2021, and 2020 all foreign currency remeasurement gains and losses were included in net loss as the Company has deemed the functional currency of its foreign subsidiary to be the U.S. Dollar. Accumulated other comprehensive loss includes foreign currency translation adjustments of \$119 thousand for the year ended December 31, 2019 that were included in other comprehensive loss prior to the designation of the U.S. Dollar as the functional currency of X4 Austria.

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Income Taxes— The Company accounts for income taxes using the asset and liability method, which requires the recognition of deferred tax assets and liabilities for the expected future tax consequences of events that have been recognized in the consolidated financial statements or in the Company’s tax returns. Deferred tax assets and liabilities are determined based on the difference between the financial statement and tax basis of assets and liabilities using enacted tax rates in effect for the year in which the differences are expected to reverse. Changes in deferred tax assets and liabilities are recorded in the provision for income taxes. The Company assesses the likelihood that its deferred tax assets will be recovered from future taxable income and, to the extent it believes, based upon the weight of available evidence, that it is more likely than not that all or a portion of the deferred tax assets will not be realized, a valuation allowance is established through a charge to income tax expense. Potential for recovery of deferred tax assets is evaluated by estimating the future taxable profits expected and considering prudent and feasible tax planning strategies.

The Company accounts for uncertainty in income taxes recognized in the consolidated financial statements by applying a two-step process to determine the amount of tax benefit to be recognized. First, the tax position must be evaluated to determine the likelihood that it will be sustained upon external examination by the taxing authorities. If the tax position is deemed more-likely-than-not to be sustained, the tax position is then assessed to determine the amount of benefit to recognize in the consolidated financial statements. The amount of the benefit that may be recognized is the largest amount that has a greater than 50% likelihood of being realized upon ultimate settlement. The provision for income taxes includes the effects of any resulting tax reserves, or unrecognized tax benefits, that are considered appropriate as well as the related net interest and penalties.

Net Loss per Share—Basic net loss per share attributable to common stockholders is computed by dividing the net loss attributable to common stockholders by the weighted average number of shares of common stock outstanding for the period. In addition, during the years ended December 31, 2022 and 2021, in accordance with the provisions of the Company’s Class B Warrants, the exercise price of each outstanding Class B Warrant was adjusted to the price of subsequent sales of common stock. Such adjustment is presented as a deemed dividend that adjusts net loss available to common shareholders for purposes of basic earnings per share. The deemed dividend is calculated using the Black-Scholes pricing model, taking into account historical volatility of the Company’s common stock and the estimated remaining life of the outstanding Class B Warrants.

Basic shares outstanding includes the weighted average effect of the Company’s outstanding prefunded warrants, the exercise of which requires little or no consideration for the delivery of shares of common stock. Diluted net loss attributable to common stockholders is computed by adjusting net loss attributable to common stockholders to reallocate undistributed earnings based on the potential impact of dilutive securities. Diluted net loss per share attributable to common stockholders is computed by dividing the diluted net loss attributable to common stockholders by the weighted average number of shares of common stock outstanding for the period, including potential dilutive shares of common stock. For purpose of this calculation, outstanding stock options, convertible preferred stock and warrants to purchase shares of convertible preferred stock or common stock are considered potential dilutive shares of common stock.

Recently Adopted Accounting Standards

On January 1, 2022, the Company adopted ASU 2021-04, *Issuer’s Accounting for Certain Modifications or Exchanges of Freestanding Equity-Classified Written Call Options*. ASU 2021-04 was issued to clarify and reduce diversity in an issuer’s accounting for modifications or exchanges of freestanding equity-classified written call options (such as warrants for the purchase of common shares) that remain classified as equity following the modification or exchange. The adoption of this standard did not have an impact on the Company’s consolidated financial statements.

On January 1, 2022, the Company adopted ASU 2021-10, *Government Assistance (Topic 832) Disclosures by Business Entities About Government Assistance*. ASU 2021-10 was issued to increase the transparency of government assistance including the disclosure of (1) the types of assistance, (2) an entity’s accounting for the assistance, and (3) the effect of the assistance on an entity’s financial statements. The Company’s foreign subsidiary, X4 Austria, participates in a research and development incentive program provided by the Austrian government whereby it is entitled to reimbursement for a percentage of qualifying research and development expenses and capital expenditures incurred. See Note 3 for disclosures required by ASU 2021-10.

In June 2016, the FASB issued ASU 2016-13, *Credit Losses (Topic 326) Measurement of Credit Losses on Financial Instruments* (“ASU 2016-13”), as amended. ASU 2016-13 requires that financial assets measured at amortized cost, such as trade receivables, be presented net of expected credit losses, which may be estimated based on relevant information such as historical experience, current conditions, and future expectation for each pool of similar financial asset. The new guidance requires enhanced disclosures related to trade receivables and associated credit losses. In accordance with ASU 2019-10, *Financial Instruments-Credit Losses (Topic 326), Derivative and Hedging (Topic 815), and Leases (Topic 842)- Effective Dates*, as the Company meets

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the definition of a “smaller reporting company”, the Company elected to defer the adoption of ASU 2016-13 until January 1, 2023. As the Company did not have accounts receivable on its consolidated balance sheet as of the date of adoption, there was no impact to the adoption of ASU 2016-13.

3. LICENSE, COLLABORATION AND FUNDING ARRANGEMENTS

Genzyme Agreement

In July 2014, the Company entered into a license agreement with Genzyme (the “Genzyme Agreement”) pursuant to which the Company was granted an exclusive license to certain patents and intellectual property owned or controlled by Genzyme related to the CXCR4 receptor to develop and commercialize products containing licensed compounds (including but not limited to mavorixafor) for all therapeutic, prophylactic and diagnostic uses, with the exception of autologous and allogenic human stem cell therapy. Under the terms of the Genzyme Agreement, the Company is obligated to use commercially reasonable efforts to develop and commercialize licensed products for use in the field in the United States and at least one other major market country. The Company has the right to grant sublicenses of the licensed rights that cover mavorixafor to third parties.

Under the Genzyme Agreement, the Company is obligated to pay Genzyme milestone payments in the aggregate amount of up to \$25.0 million, contingent upon the achievement by the Company of certain clinical-stage regulatory and sales milestones with respect to licensed products. The Company is also obligated to pay Genzyme tiered royalties based on net sales of licensed products that the Company commercializes under the agreement. The obligation to pay royalties for each licensed product expires on a country-by-country basis on the latest of (i) the expiration of licensed patent rights that cover that licensed product in that country, (ii) the expiration of regulatory exclusivity in that country and (iii) ten years after the first commercial sale of such licensed product in that country. Royalty rates are subject to reduction under the agreement in specified circumstances, including in any country if the Company is required to obtain a license from any third party to the extent the Company’s patent rights might infringe the third party’s patent rights, if a licensed product is not covered by a valid claim in that country or if sales of generic products reach certain thresholds in that country. If the Company enters into a sublicense under the Genzyme Agreement, the Company will be obligated to pay Genzyme a percentage of certain upfront fees, maintenance fees, milestone payments and royalty payments paid to the Company by the sublicensee. Under the Genzyme Agreement, the Company will itself manufacture and supply, or enter into manufacturing or supply agreements with Genzyme or third parties to manufacture and supply, clinical and commercial supplies of licensed compounds and each licensed product. The Company is also responsible for all costs related to the filing, prosecution and maintenance of the licensed patent rights.

The Genzyme Agreement will remain in effect until the expiration of the royalty term in all countries for all licensed products. The Genzyme Agreement may be terminated by either party with at least 90 days’ notice in the event of material breach by the other party that remains uncured for 90 days, by either party for insolvency or bankruptcy of the other party, immediately by Genzyme if the Company challenges the licensed patents, or immediately by the Company if a material safety issue arises.

During the year ended December 31, 2020, the Company incurred \$0.9 million of payment obligations to Genzyme. For the years ended December 31, 2022 and 2021, the Company did not incur any payment obligations to Genzyme under the Genzyme Agreement.

Georgetown Agreement

In December 2016, the Company entered into a license agreement (the “Georgetown Agreement”) with Georgetown University (“Georgetown”) pursuant to which the Company obtained an exclusive, worldwide license to make, have made, use, sell, offer for sale and import of products covered by patent rights co-owned by Georgetown. The rights licensed to the Company are for all therapeutic, prophylactic and diagnostic uses in all disease indications in humans and animals.

Under the terms of the Georgetown Agreement, the Company paid a one-time, upfront fee of \$50 thousand and the Company may be required to make milestone payments of up to an aggregate of \$800 thousand related to commercial sales of a product. Under the Georgetown Agreement, the Company is solely responsible for all development and commercialization activities and costs in its respective territories. The Company is also responsible for all costs related to the filing, prosecution and maintenance of the licensed patent rights. The term of the Georgetown Agreement will continue until the expiration of the last valid claim within the patent rights covering the product. Georgetown may terminate the agreement in the event (i) the Company fails to pay any amount and fails to cure such failure within 30 days after receipt of notice, (ii) the Company defaults in its obligation to obtain and maintain insurance and fails to remedy such breach within 45 days after receipt of notice, or (iii) the Company declares

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insolvency or bankruptcy. The Company may terminate the Georgetown Agreement at any time upon at least 60 days' written notice. During the years ended December 31, 2022, 2021 and 2020, the Company did not incur any payment obligations to Georgetown under the Georgetown Agreement and no milestone payments were made or due under the Georgetown Agreement.

Beth Israel Deaconess Medical Center Agreement

In December 2016, the Company entered into a license agreement (the "BIDMC Agreement") with Beth Israel Deaconess Medical Center ("BIDMC"), pursuant to which the Company obtained an exclusive, worldwide license to make, have made, use, sell, offer for sale and import products covered by patent rights co-owned by BIDMC. The rights licensed to the Company are for all fields of use. Under the terms of the BIDMC Agreement, the Company paid a one-time, upfront fee of \$20 thousand and the Company is responsible for all future patent prosecution costs. The Company recorded the upfront payment as research and development expense in the consolidated statement of operations because the acquired technology represented in-process research and development and had no alternative future use. The term of the BIDMC Agreement will continue until the expiration of the last valid claim within the patent rights covering the licensed products. BIDMC may terminate the agreement in the event (i) the Company fails to pay any amount and fails to cure such failure within 15 days after receipt of notice, (ii) the Company is in material breach of any material provision of the BIDMC Agreement and fails to remedy such breach within 60 days after receipt of notice, or (iii) the Company declares insolvency or bankruptcy. The Company may terminate the BIDMC Agreement at any time upon at least 90 days' written notice. The Company did not incur any payment obligations under the BIDMC Agreement during the years ended December 31, 2022, 2021 and 2020.

Dana Farber Cancer Institute Agreement

In November 2020, the Company entered into a license agreement (the "DFCI Agreement") with the Dana Farber Cancer Institute ("DFCI") pursuant to which the Company obtained a non-exclusive, royalty-bearing license to use, make, have made, develop, market, import, distribute, sell and have sold products covered by patent rights owned by DFCI. Under the terms of the DFCI Agreement, the Company paid a one-time, upfront fee of \$25 thousand and approximately \$35 thousand for reimbursement of DFCI's past patent expenses relating to the patent rights. The Company will pay 25% of DFCI's ongoing patent prosecution expenses and an annual license maintenance fee of \$10 thousand in each of the first three years, \$40 thousand in each of the subsequent three years and \$50 thousand every year after that until commercialization. The Company may be required to make milestone payments of up to an aggregate of approximately \$32.3 million related to development, regulatory and commercial sales events. No such milestone payments have been incurred to date. The Company recorded the upfront payment as research and development expense in the consolidated statement of operations and comprehensive loss because the acquired technology represented in-process research and development and had no alternative future use. The term of the DFCI Agreement will continue until the expiration of the last valid claim within the patent rights covering the product. DFCI may terminate the agreement if certain events occur.

Research and Development Incentive Program

The Company participates in a research and development incentive program provided by the Austrian government whereby the Company is entitled to reimbursement by the Austrian government for a percentage of qualifying research and development expenses incurred by the Company's subsidiary in Austria. Under the program, the reimbursement rate for qualifying research and development expenses incurred by the Company through X4 Austria is 14% for the current year. X4 Austria also participated in a COVID-19 incentive program, which provides reimbursement for qualified capital spending during a defined time period.

The Company recognizes incentive income from Austrian research and development incentives when qualifying expenses have been incurred, there is reasonable assurance that the payment will be received, and the consideration can be reliably measured. Management has assessed the Company's research and development activities and expenditures to determine which activities and expenditures are likely to be eligible under the research and development incentive program described above. At each reporting date, management estimates the reimbursable incentive income available to the Company based on available information at the time.

As of the years ended December 31, 2022 and 2021, the amounts due under these programs were \$1.2 million and \$0.7 million, respectively, which is included in research and development incentive receivable on the consolidated balance sheets. During the years ended December 31, 2022, 2021 and 2020, the Company recorded \$0.5 million, \$0.8 million and \$0.5 million, respectively, of income related to the program on the consolidated statement of operations and comprehensive loss within "other income".

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Abbisko Agreement

In July 2019, the Company entered into a license agreement with Abbisko (the “Abbisko Agreement”). Under the terms of the Abbisko Agreement, the Company granted Abbisko the exclusive right to develop, manufacture and commercialize mavorixafor in mainland China, Taiwan, Hong Kong and Macau, the (“Abbisko Territory”). The agreement provides Abbisko with the exclusive rights in the Abbisko Territory to develop and commercialize mavorixafor in combination with checkpoint inhibitors or other agents in multiple oncology indications. The Company retains the full rest-of-world rights to develop and commercialize mavorixafor outside of Greater China for all indications and the ability to utilize data generated pursuant to the Abbisko collaboration for rest-of-world development. Assuming mavorixafor is developed by Abbisko in six indications, the Company would be entitled to milestone payments of up to \$214.0 million, which will vary based on the ultimate sales, if any, of the approved licensed products. In addition, upon commercialization of mavorixafor in the Abbisko Territory, the Company is eligible to receive a tiered royalty, with a percentage range in the low double-digits, on net sales of approved licensed products. Abbisko is obligated to use commercially reasonable efforts to develop and commercialize mavorixafor in the Abbisko Territory. Abbisko has responsibility for all activities and costs associated with the further development, manufacture and commercialization of mavorixafor in the Abbisko Territory.

Following the closing of a qualified financing (as such term is defined in the Abbisko Agreement), Abbisko was required to pay the Company a one-time, non-refundable, non-creditable financial milestone payment of \$3.0 million. Abbisko achieved such qualified financing in March 2020 and, as a result, the Company was eligible to receive the milestone payment, which was received by the Company in April 2020. The Company is also eligible to receive potential development and regulatory milestone payments, which vary based on the number of indications developed, and potential commercial milestone payments based on annual net sales of mavorixafor-based licensed products.

Upon entering into the Abbisko Agreement, the Company evaluated the Abbisko Agreement under ASC 606 and determined the Abbisko Agreement contained a single performance obligation related to the exclusive license to develop and commercialize mavorixafor and the transfer of know-how that was satisfied at the inception of the arrangement. The transaction price related to the transfer of the license and know-how was fully constrained and the Company ascribed no transaction price to the development, regulatory and commercial milestones under the “most-likely amount” method. The Company concluded that any consideration related to the initial transfer of the license and know-how will be recognized when it is probable that Abbisko will achieve the related financial milestone and other operational milestones. Any consideration related to sales-based milestones (including royalties) will be recognized when the related sales occur as these amounts have been determined to relate predominantly to the license granted to Abbisko and therefore are recognized at the later of when the performance obligation is satisfied or the related sales occur. As a result of Abbisko’s achievement of the qualified financing, the Company reversed the constraint related to this milestone and recognized \$3.0 million of license revenue during the year ended December 31, 2020.

The Company determined that the future sale of clinical and commercial supply are optional goods that will be subject to the customer's future purchasing decisions and do not represent performance obligations in the Abbisko Agreement. The Company concluded that the amount to be charged for the clinical supply will be reflective of market value and, therefore, the Abbisko Agreement does not provide a discount on such supply that would be accounted for as material right at the outset of the contract. In arriving at these conclusions, the Company considered the complexity of the manufacturing process for the licensed compound and the potential ability for Abbisko to obtain the compound directly from other manufacturers in the future. The Company expects that it will recognize revenue at a point in time when such clinical supply (and commercial supply, if applicable) is delivered to Abbisko in the future.

The Company re-evaluates the transaction price, including its estimated variable consideration for milestones included in the transaction price and all constrained amounts, in each reporting period and as uncertain events are resolved or other changes in circumstances occur.

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4. FAIR VALUE OF FINANCIAL ASSETS AND LIABILITIES

The following tables present information about the Company's financial assets and liabilities measured at fair value on a recurring basis and indicate the level of the fair value hierarchy used to determine such fair values:

(in thousands)	Fair Value Measurements as of December 31, 2022 Using:			
	Level 1	Level 2	Level 3	Total
Assets:				
Cash equivalents—money market funds	\$ 70,170	\$ 2,858	\$ —	\$ 73,028
	<u>\$ 70,170</u>	<u>\$ 2,858</u>	<u>\$ —</u>	<u>\$ 73,028</u>
Liabilities:				
Embedded derivative liability	\$ —	\$ —	\$ 10	\$ 10
Class C Warrant Liability (Note 10)			23,131	23,131
	<u>\$ —</u>	<u>\$ —</u>	<u>\$ 23,141</u>	<u>\$ 23,141</u>
Fair Value Measurements as of December 31, 2021 Using:				
(in thousands)	Level 1	Level 2	Level 3	Total
Assets:				
Cash equivalents—money market fund	\$ 20,000	\$ 27,793	\$ —	\$ 47,793
	<u>\$ 20,000</u>	<u>\$ 27,793</u>	<u>\$ —</u>	<u>\$ 47,793</u>
Liabilities:				
Embedded derivative liability	\$ —	\$ —	\$ 821	\$ 821
	<u>\$ —</u>	<u>\$ —</u>	<u>\$ 821</u>	<u>\$ 821</u>

The Company's cash equivalents consisted of money market funds invested in U.S. Treasury securities. The money market funds were valued based on reported market pricing for the identical asset or by using inputs observable in active markets for similar securities, which represents a Level 2 measurement in the fair value hierarchy.

The following table provides a roll-forward of the aggregate fair values of the Company's warrant liability and derivative liability, for which fair values are determined using Level 3 inputs:

(in thousands)	Embedded Derivative Liability	PIPE Warrant Liability	Class C Warrant Liability
Balance at December 31, 2020	\$ 455	\$ —	\$ —
Change in fair value	366	0	0
Balance at December 31, 2021	821	—	—
Issuance of Class C Warrants		41,249	21,526
Change in fair value	(811)	(2,495)	1,605
Reclassification to permanent equity		(38,754)	
Balance at December 31, 2022	<u>\$ 10</u>	<u>\$ —</u>	<u>\$ 23,131</u>

Valuation of Embedded Derivative Liability— The fair value of the embedded derivative liability recognized in connection with the Company's loan agreement with Hercules (see Note 7), which is associated with additional fees due to Hercules upon events of default, was determined based on significant inputs not observable in the market, which represents a Level 3 measurement within the fair value hierarchy. The fair value of this embedded derivative liability, which is reported within other non-current liabilities on the consolidated balance sheets, is estimated by the Company at each reporting date based, in part, on the results of third-party valuations, which were prepared based on a discounted cash flow model that considered the timing and probability of occurrence of a redemption upon an event of default, the potential amount of prepayment fees or contingent interest upon an event of default and the Company's risk-adjusted discount rate of 14%. As of December 31, 2022 and December 31, 2021, the fair value of this derivative liability was \$10 thousand and \$821 thousand, respectively.

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Warrant Liabilities— On July 6, 2022, the Company issued Warrants for the purchase of its common stock in a private placement (the “PIPE Warrants”). Upon issuance, the holder’s exercise of the PIPE Warrants was conditioned on the Company increasing its authorized shares. As there were insufficient authorized shares available at the time of issuance, the PIPE Warrants were classified as a liability and measured at fair value. On September 1, 2022, upon shareholder approval of the increase to the Company’s authorized shares, the PIPE Warrants met all criteria required for permanent equity accounting and, accordingly, the Company remeasured the fair value of the warrant liability through “other income (expense)” and reclassified the fair value of the warrant liability to additional paid-in capital. In December 2022, the Company issued Class C Warrants for the purchase of shares of its common stock in a public offering. The Class C Warrants are accounted for as a liability on the consolidated balance sheet and are adjusted to fair value at period end through “other income (expense)”

The Company calculated the fair value of the PIPE Warrants and the Class C Warrants using the Black-Scholes option pricing model with the following inputs:

	PIPE Warrants		Class C Warrants	
	7/6/2022 (issuance)	9/1/2022 (reclassification to permanent equity)	12/9/2022 (issuance)	December 31, 2022
Common stock price	\$1.09	\$1.04	\$0.93	\$0.99
Risk-free interest rate	2.96 %	3.29 %	3.75 %	4.00 %
Expected term (in years)	5.00	4.86	5.00	4.92
Expected volatility	97.30 %	97.50 %	101.80 %	101.70 %
Expected dividend yield	— %	— %	— %	— %

Impairment of Goodwill

Goodwill is tested quantitatively for impairment at the reporting unit level annually in the fourth quarter, or more frequently when events or changes in circumstances indicate that the asset might be impaired. During the fourth quarter of 2021, the Company’s market capitalization, measured as the price of the Company’s common stock multiplied by common shares outstanding, was below the value of the Company’s net assets, including goodwill. As a result of the sustained decline in the market price of the Company’s common stock, the fair value of the Company’s single reporting unit, determined based on Company’s market capitalization on December 31, 2021, was lower than its carrying value and the Company concluded that goodwill was impaired. Accordingly, the Company recorded an impairment charge of \$9.8 million to reduce the carrying amount of goodwill to \$17.4 million as of December 31, 2021. The Company tested goodwill for impairment as of December 31, 2022 and concluded that goodwill was not further impaired. Should the market value of the Company’s common stock decline, additional impairment charges may be recorded in the future.

The following table provides a rollforward of the Company’s goodwill and accumulated impairment losses.

(in thousands)	Goodwill, Gross	Accumulated Impairment Loss	Goodwill
Goodwill at December 31, 2020	\$ 27,109	\$ —	\$ 27,109
Impairment losses	—	(9,758)	(9,758)
Goodwill at December 31, 2021	27,109	(9,758)	17,351
Goodwill at December 31, 2022	\$ 27,109	\$ (9,758)	\$ 17,351

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5. PROPERTY AND EQUIPMENT

Property and equipment, net consisted of the following:

(in thousands)	December 31, 2022	December 31, 2021
Leasehold improvements	\$ 228	\$ 228
Furniture and fixtures	1,268	1,251
Computer equipment	173	150
Software	24	33
Lab equipment	639	576
	2,332	2,238
Less: Accumulated depreciation and amortization	(1,228)	(724)
	<u>\$ 1,104</u>	<u>\$ 1,514</u>

Depreciation and amortization expense related to property and equipment was approximately \$513 thousand, \$499 thousand, and \$351 thousand for the years ended December 31, 2022, 2021 and 2020, respectively.

6. ACCRUED EXPENSES

Accrued expenses consisted of the following:

(in thousands)	December 31, 2022	December 31, 2021
Accrued employee compensation and benefits	\$ 6,592	\$ 5,417
Accrued external research and development expenses	3,906	1,507
Accrued professional fees	571	632
Accrued deferred financing fees	591	25
Other	374	289
	<u>\$ 12,034</u>	<u>\$ 7,870</u>

Certain reclassifications have been made to the December 31, 2021 line items on this table to conform with December 31, 2022 presentation.

7. LONG-TERM DEBT

Long-term debt consisted of the following:

(in thousands)	December 31, 2022	December 31, 2021
Principal amount of long-term debt	\$ 32,500	\$ 32,500
Debt (discount) premium, net of accretion	(196)	277
Cumulative accrual of end of term payments	1,315	1,157
Long-term debt	33,619	33,934
Less: current portion of long-term debt	(1,315)	(795)
Long-term debt, net of current portion	<u>\$ 32,304</u>	<u>\$ 33,139</u>

Hercules Loan Agreement, As Amended— In October 2018, the Company entered into a Loan and Security Agreement (the “Hercules Loan Agreement”), as subsequently amended from time to time with Hercules, under which the Company has borrowed an aggregate of \$32.5 million of term loans to date. The Hercules Loan Agreement provided for maximum borrowings of up to \$50.0 million, which included, subject to Hercules investment committee’s sole discretion, a right of the Company to request that Hercules make additional term loan advances in an aggregate amount of up to \$17.5 million through December 31,

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2022. Borrowings under the Hercules Loan Agreement accrued interest at a variable rate equal to the greater of (i) 8.75%, or (ii) *The Wall Street Journal* prime rate plus 3.75%. In an event of default, and until such event is no longer continuing, the interest rate applicable to borrowings would be increased by 4.0%. The Company concluded that each of the amendments completed during the year ended December 31, 2022 represented a modification to the debt as opposed to an extinguishment. Accordingly, fees paid to third parties directly related to the amended debt were expensed as incurred and fees paid to Hercules in conjunction with the amendment were deferred and are being amortized to interest expense over the life of the debt arrangement using the effective interest method.

Pursuant to the Hercules Loan Agreement, effective as of September 1, 2022, the Company was required to maintain cash in an account or accounts in which Hercules has a first priority security interest, in an aggregate amount greater than \$30.0 million. Following the Company's achievement of an operational performance milestone, as defined in the Hercules Loan Agreement, the required level was reduced to \$20.0 million; and provided further, that subject to the Company's filing of a NDA for mavorixafor for the treatment of WHIM syndrome, this covenant would be extinguished. As of December 31, 2022, borrowings under the Hercules Loan Agreement were repayable in monthly interest-only payments through July 1, 2023, and in equal monthly payments of principal and accrued interest from August 1, 2023 until the maturity date of the loan, which was July 1, 2024.

The Company recognized interest expense under the Hercules Loan Agreement as follows:

<i>(in thousands)</i>	For the years ended					
	2022		2021		2020	
Total interest expense	\$	3,989	\$	3,642	\$	2,686
Non-cash interest expense	\$	918	\$	756	\$	531

The annual effective interest rate on the Hercules Loan Agreement as of December 31, 2022 was 13.5%. There were no principal payments due or paid under the Hercules Loan Agreement during the year ended December 31, 2022. An end-of-term payment of \$0.8 million was paid during the year ended December 31, 2022 in accordance with the Hercules Loan Agreement.

As of December 31, 2022, future principal payments and accrued end-of-term payments due under the Hercules Loan Agreement were as follows (in thousands):

Year Ending December 31	Total	
2023	\$	14,037
2024		19,779
Long-term debt, including end-of-term payments	\$	33,816

As of December 31, 2022, the Company had the intent and ability to refinance the short-term principal obligations of the Hercules Loan Agreement to long-term, as demonstrated by entering into the Second Amended and Restated Loan and Security Agreement on January 6, 2023 as noted below. Therefore, short-term debt on the December 31, 2022 consolidated balance sheet includes only the accrued portion of certain end-of-term payments due within one year of the consolidated balance sheet date that remained due within one year of the consolidated balance sheet date following the January 6, 2023 refinancing.

Second Amended and Restated Loan and Security Agreement— On January 6, 2023, the Company entered into a Second Amended and Restated Loan and Security Agreement (the "Second A&R Loan Agreement"), which amended and restated all previous loan and security agreements with Hercules. The Second A&R Loan Agreement provides for maximum borrowings of up to \$32.5 million. Borrowings under the Second A&R Loan Agreement accrue interest at a variable rate equal to the greater of (i) 10.15%, or (ii) *The Wall Street Journal* prime rate plus 3.15%. In an event of default, and until such event is no longer continuing, the interest rate applicable to borrowings would be increased by 4.0%.

Borrowings under the Second A&R Loan Agreement are repayable in monthly interest-only payments through September 2024, and in equal monthly payments of principal and accrued interest from October 1, 2024 until the maturity date of the loan on April 1, 2026; provided however, if certain conditions are met and the Company achieves certain operational and financial milestones,

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the maturity date will be extended to July 1, 2027. Under the Second A&R Loan Agreement, the Company may prepay all, but not less than all, of the outstanding borrowings, subject to a prepayment premium of up to 3.0% of the principal amount outstanding as of the date of repayment.

Under the Second A&R Loan Agreement, the Company has agreed to affirmative and negative covenants. Pursuant to the Second A&R Loan Agreement, the Company is required to maintain cash in an account or accounts in which Hercules has a first priority security interest, in an aggregate amount greater than \$20.0 million. Upon the FDA approval of the sale and marketing of mavorixafor for the treatment to patients with WHIM syndrome with a label claim that is generally consistent with that sought in the Company's NDA filing, the required level shall be reduced to \$10.0 million. A breach of any of the covenants under the Second A&R Loan Agreement could result in a default under the loan. Upon the occurrence of an event of default under the loan facility with Hercules, the lender could elect to declare all amounts outstanding, if any, to be immediately due and payable and terminate all commitments to extend further credit. If there are any amounts outstanding that the Company is unable to repay, the lenders could proceed against the collateral granted to them to secure such indebtedness.

Borrowings under the Second A&R Loan Agreement are collateralized by substantially all of the Company's personal property and other assets except for its intellectual property (but including rights to payment an proceeds from the sale, licensing or disposition of the intellectual property). The Second A&R Loan Agreement restricts the Company's ability to incur additional indebtedness, pay dividends, encumber its intellectual property, or engage in certain fundamental business transactions, such as mergers or acquisitions of other businesses, with certain exceptions.

Under the Hercules Loan Agreement, the Company was required to pay "end-of-term" payments of \$1.3 million and \$0.8 million payable on July 1, 2023 and July 1, 2024, respectively. In connection with entering into the Second A&R Loan Agreement on January 6, 2023, the end-of-term payment of \$1.3 million was paid and the due date of the \$0.8 million end-of-term payment was accelerated to July 1, 2023. The Second A&R Loan Agreement added an additional end-of-term payment of \$1.3 million that is due on April 1, 2026. These end-of-term payments are accelerated upon the prepayment of the borrowings upon the Company's election on upon default of the loan.

As of January 6, 2023, future principal payments due under the Second A&R Loan Agreement are as follows (in thousands):

Year Ending December 31	Total
2023	\$ —
2024	5,070
2025	21,646
2026	5,784
Long-term debt	<u>\$ 32,500</u>

8. LEASES

The Company has lease agreements for its facilities in Boston, Massachusetts, which is the Company's principal executive offices; Vienna, Austria, which is the Company's research and development center; and Waltham, Massachusetts, which the Company has sublet to a third party. The Company previously had a lease agreement for a facility in Cambridge, Massachusetts, which served as its prior corporate headquarters. There are no restrictions or financial covenants associated with any of the lease agreements.

Boston Lease— The Company leases approximately 28,000 square feet of office space in Boston, Massachusetts ("Boston Lease"), which serves as the Company's headquarters. Base rental payments are approximately \$1.0 million annually, plus certain operating expenses. The term of the Boston Lease will continue until November 2026, unless earlier terminated. The Company has the right to sublease the premises, subject to landlord consent and also has the right to renew the Boston Lease for an additional five years at the then prevailing effective market rental rate. The Company is required to maintain a security deposit in the form of a letter of credit for \$0.9 million for the benefit of the landlord.

Waltham Lease— The Company leases approximately 6,000 square feet of office space in Waltham, Massachusetts ("Waltham Lease"). The Waltham Lease, as amended, commenced on January 1, 2019, and expires approximately five years from the

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commencement date. The base rent is approximately \$0.3 million annually. In addition to the base rent, the Company is also responsible for its share of operating expenses, electricity and real estate taxes, which costs are not included in the determination of the leases' right-of-use assets or lease liabilities. The Company is subleasing the space to a third party for the duration of the lease. The right-of-use asset is being amortized to rent expense over the five year term of the lease.

Vienna Austria Leases— The Company has an operating lease for approximately 1,200 square meters of laboratory and office space in Vienna, Austria ("Vienna Lease"), which commenced in February 2021 for a term of seven years. The annual base rent for the Vienna Lease is approximately \$300 thousand.

As the Company's leases do not provide an implicit rate, the Company estimated the incremental borrowing rate in calculating the present value of the lease payments. The Company utilizes its incremental borrowing rates, which are the rates incurred to borrow on a collateralized basis over a similar term an amount equal to the lease payments in a similar economic environment.

The components of lease expense for the three years ended December 31, 2022, 2021 and 2020 were as follows (dollars in thousands):

	For the Year Ended December 31,		
	2022	2021	2020
Lease Cost			
Fixed operating lease cost	\$ 2,080	\$ 2,087	\$ 1,290
Short-term lease costs	—	42	157
Total lease expense	\$ 2,080	\$ 2,129	\$ 1,447
Other information			
Operating cash flows from operating leases	\$ 1,354	\$ 1,257	\$ 3,820
Leased assets obtained in exchange for new operating lease liabilities	\$ —	\$ 1,343	\$ 5,090
Weighted-average remaining lease term—operating leases	4.0 years	5.0 years	5.5 years
Weighted-average discount rate—operating leases	11.4 %	11.3 %	11.2 %
Sublease income	\$ 196	\$ 196	\$ 194

Maturities of lease liabilities due under lease agreements that have commenced as of December 31, 2022 are as follows (in thousands):

Maturity of lease liabilities	Operating Leases
2023	\$ 1,608
2024	1,374
2025	1,402
2026	1,332
2027 and thereafter	325
Total lease payments	6,041
Less: interest	(1,240)
Total operating lease liabilities as of December 31, 2022	\$ 4,801

9. COMMITMENTS AND CONTINGENCIES

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The Company has agreements with clinical research organizations (“CROs”) pursuant to which the Company and the CROs are conducting clinical trials of mavorixafor for the treatment of WHIM syndrome, Waldenström’s and chronic neutropenia disorders. The Company may terminate these agreements by providing notice pursuant to the contractual provisions of such agreements and would incur early termination fees. The Company also has agreements with contract manufacturing organizations (“CMOs”) for the production of mavorixafor for use in clinical trials. The Company’s agreement with the CMO who produces batches of API for use in the Company’s clinical drug supply contains cancellation provisions that would require the Company to pay up to the full contract value upon cancellation. As of December 31, 2022, the Company has approximately \$1.5 million of such commitments in place subject to cancellation provisions.

License Agreements— See Note 3 for a summary of the Company’s license agreements, which commit the Company to contingent milestone and royalty fees based on future operational events.

Indemnification Agreements— In the ordinary course of business, the Company may provide indemnification of varying scope and terms to vendors, lessors, business partners and other parties with respect to certain matters including, but not limited to, losses arising out of breach of such agreements or from intellectual property infringement claims made by third parties. In addition, the Company has entered into indemnification agreements with members of its board of directors and its executive officers that will require the Company to, among other things, indemnify them against certain liabilities that may arise by reason of their status or service as directors or officers. The maximum potential amount of future payments the Company could be required to make under these indemnification agreements is, in many cases, unlimited. To date, the Company has not incurred any material costs as a result of such indemnification obligations. The Company is not currently aware of any indemnification claims and has not accrued any liabilities related to such obligations in its consolidated financial statements as of December 31, 2022 or December 31, 2021.

Legal Proceedings— The Company is not a party to any litigation and does not have contingency reserves established for any litigation liabilities. At each reporting date, the Company evaluates whether or not a potential loss amount or a potential range of loss is probable and reasonably estimable under the provisions of the authoritative guidance that addresses accounting for contingencies. The Company expenses as incurred the costs related to such legal proceedings.

10. COMMON STOCK AND REDEEMABLE COMMON STOCK

Common Stock— As of December 31, 2022, the Company’s Certificate of Incorporation, as amended and restated, authorizes the Company to issue 500 million shares of \$0.001 par value common stock. The voting, dividend and liquidation rights of the holders of the Company’s common stock are subject to and qualified by the rights, powers and preferences of the holders of the preferred stock. Each share of common stock entitles the holder to one vote on all matters submitted to a vote of the Company’s stockholders. Common stockholders are entitled to receive dividends, as may be declared by the board of directors, if any. No cash dividends have been declared or paid to date.

ATM Sales Agreement

On August 7, 2020, the Company entered into a Controlled Equity OfferingSM Sales Agreement (the “ATM Sales Agreement”) with B. Riley Securities, Inc., Cantor Fitzgerald & Co., and Stifel, Nicolaus & Company, Incorporated (collectively the “Sales Agents”), pursuant to which the Company may offer and sell, at the Company’s sole discretion through one or more of the Sales Agents, shares of its common stock having an aggregate offering price of up to \$50.0 million. To date, the Company has sold approximately \$14.3 million, net of offering costs, of common stock under the ATM Sales Agreement.

Q1 2021 Private Placement

On March 18, 2021, the Company entered into a securities purchase agreement with several institutional and accredited investors pursuant to which the Company agreed to issue and sell in a private placement (the “Private Placement”) an aggregate of 6,271,836 shares of common stock, 229,885 shares of redeemable common stock and, to certain investors, in lieu of common stock, pre-funded warrants to purchase an aggregate of 50,000 shares of common stock at a price of \$8.70 per share of common stock (or \$8.69 per pre-funded warrant). The Private Placement closed on March 23, 2021 and the Company received gross proceeds of \$55.0 million, before deducting offering expenses payable by the Company.

In August 2021, the investor who purchased the redeemable common stock exercised its option to sell its 229,885 shares of redeemable common stock back to the Company at the original purchase price of \$8.70 per share for an aggregate of \$2.0 million. The Company adjusted the carrying amount of the redeemable common stock to its redemption value and subsequently retired these shares.

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Lincoln Park Capital Fund Purchase Agreement

On January 14, 2022, the Company and Lincoln Park Capital Fund, LLC (“Lincoln Park”) entered into a securities purchase agreement (the “LPC Purchase Agreement”) and a registration rights agreement (the “Registration Rights Agreement”), pursuant to which the Company has the right to sell shares of common stock to Lincoln Park, having an aggregate value of up to \$50.0 million, subject to certain limitations and conditions set forth in the LPC Purchase Agreement, at the Company’s request from time to time during the 36-month term of the LPC Purchase Agreement. In consideration for entering into the LPC Purchase Agreement, the Company issued 230,414 shares of common stock to Lincoln Park as an initial commitment fee. Upon execution of the LPC Purchase Agreement and the Registration Rights Agreement on January 14, 2022, the Company sold to Lincoln Park, as an initial purchase under the LPC Purchase Agreement, a total of 1,382,488 shares of common stock, at a per share price of \$2.17 per share, for aggregate consideration of approximately \$3.0 million.

Q1 2022 PIPE

On March 3, 2022, the Company entered into a securities purchase agreement pursuant to which it agreed to issue and sell to an investor, in a private placement (the “Q1 2022 PIPE”), 900,000 shares of common stock at a price of \$1.80 per share, which represents the volume weighted average price per share of the Company’s common stock as quoted on the Nasdaq Stock Market for the thirty (30) consecutive-day trading day period ending on March 2, 2022, and pre-funded warrants to purchase 766,666 shares of common stock at a purchase price of \$1.79 per pre-funded warrant (representing the price of \$1.80 per share minus the \$0.01 per share exercise price of each such prefunded warrant). The pre-funded warrants are exercisable at any time after their original issuance date and will have no expiration date. The Q1 2022 PIPE closed on March 7, 2022 and the Company received gross proceeds of \$3.0 million, before deducting offering expenses payable by the Company. In accordance with an associated registration rights agreement, the Company filed a registration statement covering the resale of these securities in April 2022.

Q2 2022 PIPE

On June 30, 2022, the Company entered into a securities purchase agreement with several institutional and accredited investors pursuant to which the Company agreed to issue in a private placement (the “Q2 2022 PIPE”) an aggregate of 37,649,086 shares of common stock and, to certain investors, in lieu of common stock, pre-funded warrants to purchase an aggregate of 13,276,279 shares of common stock at a price of \$1.095 per share of common stock (or \$1.094 per pre-funded warrant) and 50,925,365 warrants (the “Warrants”) for the purchase of shares of common stock. Each Warrant has an exercise price equal to \$1.095 per share and will expire on the date that is 60 months from their original issue date. The price per pre-funded warrant represents the price of \$1.095 per share sold in the Q2 2022 PIPE, minus the \$0.001 per share exercise price of each such pre-funded warrant. The pre-funded warrants are exercisable, subject to certain beneficial ownership restrictions, at any time after their original issuance and will not expire. The Q2 2022 PIPE closed on July 6, 2022 and the Company received gross proceeds of \$55.7 million, before deducting offering expenses paid by the Company.

The exercise of any Warrant was conditioned upon the Company increasing its authorized shares. Accordingly, the Company convened a special meeting of its stockholders on September 1, 2022, during which the stockholders approved an increase in the number of authorized shares of common stock from 125 million to 500 million pursuant to an amendment to the Company’s Certificate of Incorporation. As of July 6, 2022, due to the shortfall in authorized and available common shares, the Warrants did not meet the criteria required for permanent equity accounting. As a result, the Company allocated \$41.2 million of the gross proceeds from the offering to the fair value of the Warrants, which was recorded as a warrant liability, and the remaining \$13.5 million was allocated to the common shares and pre-funded warrants and recorded as permanent equity. The fair value of the warrant liability was calculated using the Black-Scholes option valuation model. The Company also allocated a portion of the transaction fees, including commissions and legal fees, to the warrant liability and expensed within other expense, net, approximately \$2.9 million of these fees upon the closing of the Q2 2022 PIPE. Upon shareholder approval of the increase to the Company’s authorized shares, the Warrants met all criteria required for permanent equity accounting and, accordingly, the Company remeasured the fair value of the warrant liability through earnings, which resulted in approximately \$2.5 million of income included within other income (expense) and reclassified the fair value of the warrant liability to additional paid-in capital.

Also on June 30, 2022, the Company entered into a registration rights agreement, pursuant to which the Company agreed to register for resale the common shares issued in the Q2 2022 PIPE and the issuance of the shares of common stock underlying the Pre-Funded Warrants and the Warrants sold in the offering. Such registration statement was filed on July 29, 2022 and was declared effective by the SEC on August 5, 2022.

Q4 2022 Public Offering

On December 7, 2022, the Company sold 52,300,000 shares of common stock and, in lieu of common stock, prefunded warrants to purchase 6,800,000 shares of common stock, and accompanying Class C warrants to purchase 32,762,947 shares of its common

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stock. The common stock was issued at a price to the public of \$1.10 per share and the accompanying Class C warrants and prefunded warrants were issued at a price of \$1.099 per prefunded warrant and accompanying Class C warrant. The Class C warrants have an exercise price of \$1.50, will expire 5 years from the date of issuance, and are immediately exercisable with certain restrictions. The gross proceeds from the offering, which closed on December 9, 2022, were \$65.1 million before deducting underwriting discounts and offering expenses.

The Company has concluded that the Class C warrants do not meet the equity contract scope exception under ASC 815-40 as in the event of a fundamental transaction such as a merger certain provisions may require the Company to adjust the settlement value that is not consistent with a fixed-for-fixed option pricing model. As a result, as of issuance date, the Company allocated \$21.5 million of the gross proceeds from the offering to the Class C Warrants based on their fair value, which was recorded as a warrant liability, and the remaining \$43.6 million was allocated to the common shares and pre-funded warrants and recorded as permanent equity. The warrant liability was subsequently adjusted to fair value at December 31, 2022 and will be adjusted to fair value at each subsequent balance sheet date until the warrants are settled. Changes in fair value of the warrants are recognized as a component of other income (expense), net in the consolidated statement of operations and comprehensive loss.

The fair value of the warrant liability was calculated using the Black-Scholes option valuation model as further described in Note 4. The Company also allocated a portion of the transaction fees, including commissions and legal fees, to the Class C Warrant liability and expensed within other expense, net, approximately \$1.7 million of these fees upon the closing of the Q4 2022 Public Offering.

For each of the common stock offerings, the Company evaluated the common stock, warrants and prefunded warrants for liability or equity classification in accordance with the provisions of ASC 480, *Distinguishing Liabilities from Equity*, and ASC 815-40, *Derivatives and Hedging*, and, other than as described above for warrants issued in the Q2 2022 PIPE and the Q4 2022 Public Offering, determined that equity treatment was appropriate as the warrants and prefunded warrants did not meet the definition of a liability.

11. COMMON STOCK WARRANTS

Class A Warrants

In connection with its issuance of common stock in public offerings that closed on April 16, 2019, the Company issued 3,900,000 Class A warrants, which are exercisable for shares of the Company's common stock or prefunded warrants to purchase shares of the Company's common stock. The Class A warrants have an exercise price of \$13.20 per warrant, expire on April 15, 2024 and were immediately exercisable upon issuance.

Class B Warrants

In connection with its issuance of common stock in public offerings that closed on November 29, 2019, the Company issued 5,416,667 Class B warrants, which are exercisable for shares of the Company's common stock or prefunded warrants to purchase shares of the Company's common stock.

The Class B warrants were immediately exercisable upon issuance, had an initial exercise price of \$15.00 per share, which in accordance with the Class B warrant agreement was subsequently reduced to the price at which the Company sold its common shares in public offering or private placements. The Class B warrants expired in accordance with the Class B warrant agreement on December 29, 2022, which was 30 calendar days from the date on which the Company issued a press release announcing top-line data from its Phase 3 clinical trial of mavoxixafor for the treatment of patients with WHIM syndrome.

Q2 PIPE Warrants

In connection with its issuance of common stock and prefunded warrants in a private placement that closed on July 6, 2022, the Company issued warrants to purchase an aggregate of 50,925,365 warrants (the "Warrants") for the purchase of shares of common stock. Each Warrant has an exercise price equal to \$1.095 per share and will expire on the date that is 60 months from their original issue date.

Class C Warrants

In connection with its issuance of common stock in public offerings that closed on December 9, 2022, the Company issued

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65,525,894 Class C warrants, which are exercisable at two Class C warrants for one share of the Company's common stock or prefunded warrants to purchase shares of the Company's common stock. The Class C warrants have an exercise price of \$1.50 per set of two Class C warrants, expire on December 9, 2027 and were immediately exercisable upon issuance.

Pre-funded Warrants

In connection with the sale of its common stock in public offerings and private placements, the Company has issued pre-funded warrants to purchase shares of its common stock. The price per pre-funded warrant represents the price per share sold in the public offering or private placement, minus a nominal exercise price of either \$0.001 or \$0.01 per share, in accordance with the applicable pre-funded warrant agreement. The pre-funded warrants are exercisable, subject to certain beneficial ownership restrictions, at any time after their original issuance and will not expire.

The following table provides a roll forward of outstanding warrants and pre-funded warrants for the purchase of shares of the Company's common stock for the three years ended December 31, 2022:

	Number of warrants	Weighted Average Exercise Price	Weighted Average Contractual Term (Years)
Outstanding and exercisable as of December 31, 2020	13,354,403	\$ 13.52	3.72
Issued	2,058,032		
Exercised	(2,130,000)		
Expired	(25,275)		
Outstanding and exercisable as of December 31, 2021	13,257,160	\$ 7.96	2.72
Issued	104,531,257		
Exercised	(500,100)		
Expired	(5,416,567)		
Outstanding and exercisable as of December 31, 2022	111,871,750	\$ 1.86	4.53

As of December 31, 2022, the Company's outstanding warrants and pre-funded warrants to purchase shares of common stock consisted of the following:

Issuance Date	Number of Shares of Common Stock Issuable	Exercise Price	Expiration Date
October 25, 2016	5,155	\$ 19.78	October 24, 2026
December 28, 2017	115,916	\$ 19.78	December 28, 2027
September 12, 2018	20,220	\$ 19.78	September 12, 2028
October 19, 2018	20,016	\$ 19.78	October 19, 2028
March 13, 2019	5,000	\$ 19.78	March 12, 2029
April 16, 2019	3,866,154	\$ 13.20	April 15, 2024
November 29, 2019	1,250,000	\$ 12.00 (a)	n/a
March 23, 2021	50,000	\$ 8.70 (b)	n/a
November 9, 2021	2,008,032	\$ 4.98 (c)	n/a
March 3, 2022	766,666	\$ 1.80 (d)	n/a
July 6, 2022	13,276,279	\$ 1.095 (e)	n/a
July 6, 2022	50,925,365	\$ 1.095	July 6, 2027
December 9, 2022	32,762,947	\$ 1.50	December 9, 2027
December 9, 2022	6,800,000	\$ 1.10 (f)	n/a
	<u>111,871,750</u>		

(a) In November 2019, the Company received \$11.999 per pre-funded warrant, or \$21.0 million in aggregate proceeds. Each pre-funded warrant may be exercised for an additional \$0.001 per pre-funded warrant; (b) In March 2021, the Company received \$8.69 per pre-funded warrant, or \$435 thousand in aggregate proceeds. Each pre-funded warrant may be exercised for an additional \$0.01 per pre-funded warrant; (c) In November 2021, the Company received \$4.97 per pre-funded warrant, or \$10.0 million in aggregate proceeds. Each pre-funded warrant may be exercised for an additional \$0.01 per pre-funded warrant; (d) In March 2022, the Company received \$1.79 per pre-funded warrant, or \$1.40 million in aggregate proceeds. Each pre-funded warrant may be exercised for an

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additional \$0.01 per pre-funded warrant; (e) In July 2022, the Company received \$1.094 per pre-funded warrant, or \$14.5 million in aggregate proceeds. Each pre-funded warrant may be exercised for an additional \$0.001 per pre-funded warrant; and (f) In December 2022, the Company received \$1.099 per pre-funded warrant, or \$7.5 million in aggregate proceeds. Each pre-funded warrant may be exercised for an additional \$0.001 per pre-funded warrant.

12. STOCK-BASED COMPENSATION

Summary of Plans— The Company issues stock awards under the following plans: (a) The 2015 Employee, Director and Consultant Equity Incentive Plan, as amended (the “2015 Plan”), (b) the Amended and Restated 2017 Equity Incentive Plan (the “2017 Plan”), (c) the 2017 Employee Stock Purchase Plan (the “2017 ESPP”) and the 2019 Inducement Equity Incentive Plan (the “2019 Plan”).

These plans are administered by the Board of Directors or by a committee thereof. The exercise prices, vesting and other restrictions are determined at the discretion of the Board of Directors, or its committee if so delegated, except that the exercise price per share of stock options may not be less than 100% of the fair market value of the share of common stock on the date of grant and the term of the stock option may not be greater than ten years. Incentive stock options granted to employees and restricted stock awards granted to employees, officers, members of the Board of Directors, advisors, and consultants of the Company typically vest over four years. Non-statutory options granted to employees, officers, members of the Board of Directors, advisors, and consultants of the Company typically vest over three or four years. Shares that are expired, terminated, surrendered or canceled under the Plans without having been fully exercised will be available for future awards. In addition, shares of common stock that are tendered to the Company by a participant to exercise an award are added to the number of shares of common stock available for the grant of awards.

2015 Employee, Director and Consultant Equity Incentive Plan—Under the 2015 Plan, the Company grants incentive stock options, nonqualified stock options, restricted stock awards and other stock-based awards to employees, directors and consultants of the Company. As of December 31, 2022, there were approximately 19 thousand shares available for issuance under the 2015 Plan.

2017 Equity Incentive Plan— Under the 2017 Plan, the Company may grant incentive stock options, non-qualified options, stock appreciation rights, restricted stock awards, restricted stock units and other stock-based awards. Under an “evergreen” provision of the 2017 Plan, shares of common stock reserved for issuance under the 2017 Plan are increased annually on the first day of each year, beginning on January 1, 2021 and ending on January 1, 2027, in an amount equal to the lower of 4.0% of the number of shares of the Company’s common stock outstanding on January 1 of each year or an amount determined by the Company’s Board of Directors. As of December 31, 2022, approximately 298 thousand shares were available for future issuance under the 2017 Plan. As of January 1, 2023, an additional 4.8 million shares became available for future issuance under the 2017 Plan under the evergreen provision.

2017 Employee Stock Purchase Plan— The 2017 ESPP provides participating employees with the opportunity to purchase shares of the Company’s common stock at defined purchase prices over six-month offering periods. For the twelve months ended December 31, 2022, 204,903 shares of common stock were issued under the 2017 ESPP. As of December 31, 2022, approximately 64 thousand shares were available for future issuance under the 2017 ESPP. Pursuant to the evergreen provision of the 2017 ESPP, on January 1, 2023, an additional 85 thousand shares became available for future issuance under the 2017 ESPP.

2019 Inducement Equity Incentive Plan— On June 17, 2019, the Board of Directors approved the adoption of the 2019 Plan, as amended, which is used exclusively for the grant of equity awards to individuals who were not previously employees of the Company (or following a bona fide period of non-employment), as an inducement material to such individual’s entering into employment with the Company, pursuant to Nasdaq Listing Rule 5635(c)(4). The total number of shares of common stock that may be issued under the 2019 Plan, as amended, is 2.3 million shares. Shares that are expired, forfeited, canceled or otherwise terminated without having been fully exercised will be available for future grant under the 2019 Plan. In addition, shares of common stock that are tendered to the Company by a participant to exercise an award are added to the number of shares of common stock available for future grants. As of December 31, 2022, approximately 1.3 million shares were available for future issuance under the 2019 Plan.

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Stock Option Valuation— The following table presents, on a weighted average basis, the assumptions used in the Black-Scholes option-pricing model to determine the grant-date fair value of stock options granted:

	Year Ended December 31,		
	2022	2021	2020
Risk-free interest rate	3.4 %	1.0 %	0.6 %
Expected term (in years)	6.06	5.96	6.01
Expected volatility	96.0 %	97.3 %	94.9 %
Expected dividend yield	0 %	0 %	0 %

Stock Options

The following table summarizes the Company's stock option activity for the twelve months ended December 31, 2022:

	Number of Shares	Weighted Average Exercise Price	Weighted Average Contractual Term (in Years)	Aggregate Intrinsic Value (in Thousands)
Outstanding as of December 31, 2021	1,916,051	\$ 10.01	7.8	\$ —
Granted	759,200	1.76		
Forfeited	(653,771)	9.75		
Outstanding as of December 31, 2022	<u>2,021,480</u>	\$ 6.99	6.5	\$ 1
Exercisable as of December 31, 2022	<u>1,114,604</u>	\$ 9.93	6.3	\$ —
Vested and expected to vest as of December 31, 2022	<u>1,722,110</u>	\$ 7.77	7.3	\$ —

The aggregate intrinsic value of options is calculated as the difference between the exercise price of the stock options and the fair value of the Company's common stock to the extent the stock option had a lower exercise price. The aggregate intrinsic value of stock options exercised during the twelve months ended December 31, 2021 and 2020 was \$13 thousand and \$42 thousand, respectively. There were no stock options exercised for the twelve months ended December 31, 2022. The weighted average grant-date fair value per share of stock options granted during the years ended December 31, 2022, 2021 and 2020 was \$1.38, \$5.17, and \$6.12, respectively.

Restricted Stock Units— During the twelve months ended December 31, 2022, the Company granted 1.8 million restricted stock units to employees at a weighted average grant date fair value of \$2.09 per share. These restricted stock units are time-based and vest annually as the employee provides services to the Company. The Company recognizes stock-based compensation expense ratably, net of estimated forfeitures, over the estimated vesting period.

The following table summarizes the Company's restricted stock activity for the twelve months ended December 31, 2022:

	Number of Shares
Unvested at December 31, 2021	925,101
Granted	1,814,425
Vested	(384,814)
Forfeited	(674,149)
Unvested at December 31, 2022	<u>1,680,563</u>

Stock-Based Compensation— As of December 31, 2022, total unrecognized compensation expense related to unvested stock options and restricted stock units was \$4.4 million, which is expected to be recognized over a weighted average period of 1.5 years.

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Stock-based compensation expense was classified in the consolidated statements of operations as follows:

	Year Ended December 31,		
	2022	2021	2020
Research and development expense	\$ 2,534	\$ 2,723	\$ 2,316
Selling, general and administrative expense	2,665	3,457	3,112
Total stock-based compensation	<u>\$ 5,199</u>	<u>\$ 6,180</u>	<u>\$ 5,428</u>

Stock Appreciation Rights— On November 7, 2022 (the “Grant Date”), the compensation committee of the Board of Directors approved special retention and recognition grants of stock appreciation rights pursuant to the 2017 Plan to the Company’s President and Chief Executive Officer, the Company’s Chief Financial Officer and Treasurer, and certain other executive officers of the Company. The SARs have a measurement price per SAR equal to \$1.80, the closing price per share of the Company’s common stock on the Grant Date, and each grant of SARs will have a maximum term of ten years from the Grant Date. Unless otherwise determined by the Board of Directors, the SARs will be settled in cash upon exercise. The settlement value will be based on the difference between the closing price of the Company’s common stock on the date of settlement less \$1.80 multiplied by the number of SARs exercised. The SARs will vest and become exercisable in equal annual installments on the first, second, and third anniversaries of the Grant Date, subject to the recipient remaining an employee of the Company through and including each applicable vesting date.

The calculation of the fair value of the outstanding SARs includes the closing price of the Company’s common stock of \$0.99 and the following assumptions on a weighted average basis:

	December 31, 2022
Risk-free interest rate	3.95 %
Expected term (in years)	5.86
Expected volatility	96.96 %
Expected dividend yield	— %
Expected Forfeiture Rate	22 %

The SARs are accounted for as liability awards as settlement will be in the form of cash unless the Board of Directors authorizes settlement in shares of the Company’s common stock and such shares are available to be issued from the 2017 Plan. The Company currently intends to settle the SARs in cash if and when exercised. Compensation expense is recorded based the fair value of the SARs, as determined using the Black-Scholes option valuation model, using an accelerated attribution method as the SARs vest. The Company remeasures the fair value of the outstanding SARs each period until settlement and adjusts life-to-date compensation expense to the period end SARs fair value. For the year ended December 31, 2022, the Company recognized \$373 thousand of compensation expense related to the SARs.

13. INCOME TAXES

During the years ended December 31, 2022, 2021, and 2020, the Company recorded no income tax benefits for the net operating losses incurred and research and development credits generated due to the uncertainty of realizing a benefit from those items. Additionally during the years ended December 31, 2022, 2021 and 2020, the Company recorded immaterial a tax provisions related to its Austrian subsidiary. Also during the year ended December 31, 2020, the Company recorded a U.S. tax provision related to local withholdings associated with a milestone payment received from a customer in a foreign jurisdiction.

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Loss before the provision for income taxes for the years ended December 31, 2022, 2021 and 2020 consisted of the following:

(in thousands)	Year Ended December 31,		
	2022	2021	2020
United States	\$ (94,742)	\$ (89,865)	\$ (62,539)
Foreign (Austria)	903	1,186	556
	<u>\$ (93,839)</u>	<u>\$ (88,679)</u>	<u>\$ (61,983)</u>

A reconciliation of the U.S. federal statutory income tax rate to the Company's effective income tax rate is as follows:

	Year Ended December 31,		
	2022	2021	2020
U.S. federal statutory income tax rate	(21.0)%	(21.0)%	(21.0)%
State income taxes, net of federal benefit	(5.5)	(5.4)	(5.9)
Research and development tax credits	(1.0)	(0.9)	(1.1)
Other permanent differences	3.0	3.7	0.9
Change in deferred tax asset valuation allowance	23.2	23.7	27.2
Other	1.3	(0.1)	0.1
Effective income tax rate	<u>— %</u>	<u>— %</u>	<u>0.2 %</u>

Net deferred tax assets as of December 31, 2022 and 2021 consisted of the following:

(in thousands)	December 31,	
	2022	2021
Net operating loss carryforwards	\$ 107,296	\$ 101,863
Research and development tax credit carryforwards	6,694	5,444
Capitalized research and development expenses	16,004	1,760
Lease liabilities	1,016	1,243
Other	3,604	3,372
Total deferred tax assets	134,614	113,682
Valuation allowance	(133,112)	(111,835)
Deferred tax assets, net of valuation allowance	<u>\$ 1,502</u>	<u>\$ 1,847</u>
Right of use assets	1,502	1,847
Total deferred tax liabilities	<u>\$ 1,502</u>	<u>\$ 1,847</u>
Total deferred tax assets, net	<u>\$ —</u>	<u>\$ —</u>

As of December 31, 2022, the Company had U.S. federal and state net operating loss carryforwards of \$342.9 million and \$336.5 million, respectively, which may be available to offset future taxable income and begin to expire in 2031 and 2035, respectively. The Company has federal net operating losses \$288.8 million, which do not expire, and \$54.1 million of federal net operating losses generated prior to 2018 that will expire at various dates through 2037. In addition, as of December 31, 2022, the Company had foreign net operating loss carryforward of \$61.2 million, which do not expire but are generally limited in their usage to an annual deduction equal to 75% of taxable income. As of December 31, 2022, the Company also had U.S. federal and state research and development tax credit carryforwards of \$5.2 million and \$1.9 million, respectively, which may be available to offset future tax liabilities and each begin to expire in 2032 and 2030, respectively.

The Tax Cuts and Jobs Act (the "Act") was enacted on December 22, 2017. Under the Act, research and experimental

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expenditures incurred for tax years beginning after December 31, 2021 must be capitalized and amortized ratably over five or fifteen years for tax purposes, depending on where the research activities are conducted, in accordance with Section 174 of the Internal Revenue Code (“Section 174 Expenditures”). For the year ended December 31, 2022, the Company capitalized \$59.0 million and received \$5.3 million of amortization deductions related to such Section 174 Expenditures, which on a tax-effected basis represent \$14.7 million of the deferred tax assets shown in “Capitalized research and development costs” in the table above. The Company has elected to treat global intangible low-taxed income (“GILTI”) as a period cost, so the capitalization of research and experimental costs in GILTI increases the Company’s provision for income taxes. If the requirement to capitalize Section 174 expenditures is not modified, it may also impact our effective tax rate and our cash tax liability in future years.

As of December 31, 2022, uncertain tax position reserves recorded were \$0.2 million for U.S. federal and state research and development tax credits.

The following table summarizes the Company’s reserve for uncertain tax positions for the three years ended December 31, 2022:

(in millions)	Reserve for Uncertain Tax Position
Balance as of December 31, 2020	\$ 0.3
Settlement of unrecognized tax benefit	(0.1)
Balance as of December 31, 2021	<u>0.2</u>
Balance as of December 31, 2022	<u>\$ 0.2</u>

Utilization of the U.S. net operating loss carryforwards and research and development tax credit carryforwards may be subject to a substantial annual limitation under Section 382 of the Internal Revenue Code of 1986 due to ownership changes that have occurred previously or that could occur in the future. These ownership changes may limit the amount of carryforwards that can be utilized annually to offset future taxable income. In general, an ownership change, as defined by Section 382, results from transactions increasing the ownership of certain shareholders or public groups in the stock of a corporation by more than 50% over a three-year period. The Company has not conducted a study to assess whether a change of control has occurred or whether there have been multiple changes of control since inception due to the significant complexity and cost associated with such a study. If the Company has experienced a change of control, as defined by Section 382, at any time since inception, utilization of the U.S. net operating loss carryforwards or research and development tax credit carryforwards would be subject to an annual limitation under Section 382, which is determined by first multiplying the value of the Company’s stock at the time of the ownership change by the applicable long-term tax-exempt rate, and then could be subject to additional adjustments, as required. Any limitation may result in expiration of a portion of the net operating loss carryforwards or research and development tax credit carryforwards before utilization.

Each period, the Company evaluates the positive and negative evidence bearing upon its ability to realize its federal, state and foreign deferred tax assets. Management has considered the Company’s history of cumulative net losses incurred since inception and its lack of commercialization of any products or generation of any revenue from product sales since inception and has concluded that it is more likely than not that the Company will not realize the benefits of its deferred tax assets. Accordingly, a full valuation allowance has been established against the deferred tax assets as of December 31, 2022, 2021 and 2020.

Changes in the valuation allowance for deferred tax assets during the years ended December 31, 2022, 2021 and 2020 related primarily to the increases in net operating loss carryforwards and research and development tax credit carryforwards and were as follows:

(in thousands)	Year Ended December 31,		
	2022	2021	2020
Valuation allowance, beginning of year	\$ (111,835)	\$ (92,197)	\$ (73,410)
Increases recorded to income tax provision	(21,277)	(19,638)	(18,787)
Valuation allowance, end of year	<u>\$ (133,112)</u>	<u>\$ (111,835)</u>	<u>\$ (92,197)</u>

X4 PHARMACEUTICALS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

The Company's U.S. federal and state income tax returns are generally subject to tax examinations for the tax years ended December 31, 2019 through December 31, 2021. There are currently no pending income tax examinations. To the extent the Company has tax attribute carryforwards, the tax years in which the attribute was generated may still be adjusted upon examination by the Internal Revenue Service and state tax authorities to the extent utilized in a future period. The Company's policy is to record interest and penalties related to income taxes as part of its income tax provision.

14. NET LOSS PER SHARE

Basic and diluted net loss per share attributable to common stockholders was calculated as follow:

(in thousands, except per share data)	Year Ended December 31,		
	2022	2021	2020
Numerator:			
Net loss	\$ (93,867)	\$ (88,696)	\$ (62,131)
Deemed dividend as a result of Class B Warrant price reset	(2,546)	(13,943)	—
Net loss attributable to common stockholders	\$ (96,413)	\$ (102,639)	\$ (62,131)
Denominator:			
Weighted average shares of common stock—basic and diluted	63,526	25,749	20,077
Net loss per share attributable to common stockholders— basic and diluted	\$ (1.52)	\$ (3.99)	\$ (3.09)

Basic and diluted weighted average shares of common stock outstanding for the three years ended December 31, 2022 includes the weighted average effect of 24,150,977 pre-funded warrants, for the purchase of shares of common stock, for which the remaining unfunded exercise price is less than or equal to \$0.01 per share. During the years ended December 31, 2022 and 2021, in accordance with the Class B Warrant agreement, the exercise price of each outstanding Class B Warrant was adjusted to the price of subsequent sales of common stock. Such adjustments are accounted for as a deemed dividend that adjusts net loss available to common shareholders for purposes of basic earnings per share. The deemed dividend is calculated using the Black-Scholes pricing model, taking into account historical volatility of the Company's common stock and the estimated remaining life of the outstanding Class B Warrants.

The Company's potentially dilutive securities included outstanding stock options, unvested restricted stock units and warrants to purchase shares of common stock for the three years ended December 31, 2022. These potentially dilutive securities have been excluded from the computation of diluted net loss per share as the effect would be to reduce the net loss per share, and thus they are considered "anti-dilutive." Therefore, the weighted average number of common shares outstanding used to calculate both basic and diluted net loss per share attributable to common stockholders is the same. The Company excluded the following potential shares of common stock from the computation of diluted net loss per share attributable to common stockholders for the periods indicated because including them would have had an anti-dilutive effect:

	Year Ended December 31,		
	2022	2021	2020
Options to purchase common stock	2,021,480	1,916,051	1,874,514
Unvested restricted stock units	1,680,563	925,101	572,460
Warrants to purchase common stock (excluding prefunded warrants, which are included in basic shares outstanding)	87,720,773	9,449,128	9,474,403
	91,422,816	12,290,280	11,921,377

15. GAIN ON SALE OF NONFINANCIAL ASSETS

During the year ended December 31, 2022, a third party, who had previously acquired rights to certain intellectual property from the Company, terminated the arrangement and transferred these rights back to the Company. Also during the year ended December 31, 2022, the Company transferred these rights to another third party in return for \$0.5 million. The

Company has no continuing involvement in any ongoing research and development activities associated with the intellectual property. The Company concluded that these third parties are "non-customers" as the underlying intellectual property transferred to and from these third parties supports potential drug candidates that are not aligned with the Company's strategic focus and, therefore, are not an output of the Company's ordinary activities. Accordingly, the Company accounted for the sale of the intellectual property as the sale of a non-financial asset under ASC Topic 610-20, *Gains and Losses from the Derecognition of Nonfinancial Assets* ("ASC 610-20"), and included the gain in gain on sale of non-financial asset for the year ended December 31, 2022.

16. SUBSEQUENT EVENTS

Second Amendment and Restatement of Hercules Loan Agreement

As further disclosed in Note 7, on January 6, 2023, the Company entered the Second A&R Loan Agreement with Hercules, which provides for a term loan of \$32.5 million. The Second A&R Loan Agreement amended and restated the previous loan and security agreement, as amended. The Second A&R Loan Agreement does not require any scheduled amortization payments prior to October 1, 2024; provided however, if certain conditions are met, then amortization payments will not be required until January 1, 2026. The entire principal balance and all accrued but unpaid interest shall be due on the maturity date, which is April 1, 2026; provided however, if certain conditions are met, the maturity date will be extended to July 1, 2027. Borrowings bear interest at a per annum rate equal to the greater of (i) 3.15% plus *The Wall Street Journal* prime rate or (ii) 10.15%. Interest payments are due on a monthly basis. In an event of default and until such event is no longer continuing, the interest rate applicable to borrowings under the Second A&R Loan Agreement would be increased by 4.00%. Please see Note 7 for further disclosures related to the Second A&R Loan Agreement with Hercules.

Borrowings under the Second A&R Loan Agreement are collateralized by substantially all of the Company's personal property and other assets except for their intellectual property (but including rights to payment and proceeds from the sale, licensing or disposition of the intellectual property). Under the Second A&R Loan Agreement, the Borrowers have agreed to affirmative and negative covenants to which the Company will remain subject until maturity or repayment in full. Such covenants include maintaining a minimum liquidity amount of cash and cash equivalents in an aggregate amount greater than or equal to \$20.0 million or, on and after certain conditions have been met, cash and cash equivalents in an aggregate amount greater than or equal to \$10.0 million. The Company's obligations under the Second A&R Loan Agreement are subject to acceleration upon occurrence of specified events of default, including payment default, insolvency and a material adverse change in the Company's business, operations or financial or other condition. In addition, under the Second A&R Loan Agreement, Hercules has the right to participate, in a cumulative amount of up to \$1.0 million in the aggregate, and subject to exceptions as provided in the Second A&R Loan Agreement, in any future offering of the Company's equity securities for cash that is solely for financing purposes and is broadly marketed to multiple investors.

DESCRIPTION OF SECURITIES REGISTERED UNDER SECTION 12 OF THE SECURITIES EXCHANGE ACT OF 1934

The following description of our common stock and provisions of our restated certificate of incorporation, as amended (“restated certificate”), and amended and restated by-laws (“by-laws”) are summaries, and does not purport to be complete and is subject to, and is qualified in its entirety by reference to, the applicable provisions of the restated certificate, by-laws and forms of warrants, each of which is filed as an exhibit to the Company’s Annual Report on Form 10-K of which this Exhibit 4.17 is a part. We encourage you to review the terms and provisions set forth therein for additional information.

Authorized Capital Stock

Our restated certificate authorizes us to issue up to 500,000,000 shares of common stock, \$0.001 par value per share, and 10,000,000 shares of preferred stock, \$0.001 par value per share.

Common Stock

Holders of our common stock are entitled to one vote for each share held on all matters submitted to a vote of stockholders and do not have cumulative voting rights. An election of directors by our stockholders shall be determined by a plurality of the votes cast by the stockholders entitled to vote on the election. Holders of common stock are entitled to receive proportionately any dividends as may be declared by our board of directors, subject to any preferential dividend rights of any series of preferred stock that we may designate and issue in the future.

In the event of our liquidation or dissolution, the holders of common stock are entitled to receive proportionately our net assets available for distribution to stockholders after the payment of all debts and other liabilities and subject to the prior rights of any outstanding preferred stock. Holders of common stock have no preemptive, subscription, redemption or conversion rights. There are no redemption or sinking fund provisions applicable to the common stock. The rights, preferences and privileges of holders of common stock are subject to and may be adversely affected by the rights of the holders of shares of any series of preferred stock that we may designate and issue in the future.

Warrants to Purchase Common Stock

In March 2019, Arsanis, Inc. completed a business combination with X4 Therapeutics, Inc., formerly X4 Pharmaceuticals, Inc. (“Legacy X4”) and changed its name to X4 Pharmaceuticals, Inc. In connection with such business combination, certain then-outstanding warrants issued by Legacy X4 to purchase preferred stock of Legacy X4 were exchanged for warrants to purchase common stock of X4 Pharmaceuticals, Inc., formerly Arsanis, Inc. (the “Legacy Warrants”). We also authorized and issued a warrant to Hercules Capital Inc. (the “Hercules Warrant”), Class A warrants (the “Class A Warrants”), Class B warrants (which expired on December 29, 2022), Class C warrants (the “Class C Warrants”), pre-funded warrants (the “Pre-Funded Warrants”) and certain warrants in a private placement (the “Private Placement Warrants”).

The number of shares of common stock to be received upon the exercise of such warrants may be adjusted from time to time upon the occurrence of certain events, including, but not limited to, stock dividends, stock splits, reorganizations or similar events affecting our common stock and the exercise price. Further, the exercise price and number of shares of common stock to be received upon the exercise of the warrants are subject to appropriate adjustment in the event our company consummates certain change in control or capital reorganization transactions as set forth in such warrants. Subject to applicable laws, each warrant may be transferred at the option of the holder upon surrender of such warrant to us together with the appropriate instruments of transfer.

Legacy Warrants

As of December 31, 2022, there were 161,307 Legacy Warrants outstanding at an exercise price of \$19.78 per share. Each Legacy Warrant entitle the holder to purchase one share of our common stock and is subject to adjustment as discussed above.

The Legacy Warrants will expire on:

- October 24, 2026 as to 5,155 Legacy Warrants outstanding;
- December 28, 2027 as to 115,916 Legacy Warrants outstanding;
- September 12, 2028 as to 20,220 Legacy Warrants outstanding; and
- October 19, 2028 as to 20,016 Legacy Warrants outstanding.

Hercules Warrant

As of December 31, 2022, the Hercules Warrant was outstanding and entitles the holder to purchase 5,000 shares of our common stock at an exercise price of \$19.80 per share. The Hercules Warrant expires on March 12, 2029.

Class A Warrants

In connection with our issuance of securities in a public offering that closed on April 16, 2019, we issued 3,900,000 Class A Warrants, which have an exercise price of \$13.20 per share and expire on April 15, 2024. The Class A Warrants became immediately exercisable upon issuance, provided that each holder of Class A Warrants is prohibited, subject to certain exceptions, from exercising the Class A Warrant for shares of our common stock to the extent that immediately prior to or after giving effect to such exercise, the holder, together with its affiliates and other attribution parties, would own more than 9.99% of the total number of shares of our common stock then issued and outstanding, which percentage may be changed at the holders' election to a higher or lower percentage not in excess of 19.99% (if exceeding such percentage would result in a change of control under Nasdaq Listing Rule 5636(b) or any successor rule) upon 61 days' notice to us subject to the terms of the Class A Warrants. If there is no effective registration statement at the time of exercise, the Class A Warrants may be exercised cashlessly.

As of December 31, 2022, 3,866,154 Class A Warrants were outstanding and remain unexercised.

Private Placement Warrants

In connection with our issuance of securities in a private placement that closed on July 6, 2022, we issued Private Placement Warrants to purchase an aggregate of 50,925,365 shares of common stock or Pre-Funded Warrants. Each Private Placement Warrant has an exercise price equal to \$1.095 per share and will expire on July 6, 2027.

The Private Placement Warrants became immediately exercisable upon issuance, provided that each holder of Private Placement Warrants may not exercise any portion of the Private Placement Warrants if such holder, together with its affiliates, would beneficially own in excess of 4.99% or 9.99% of the number of shares of our common stock outstanding immediately after giving effect to such exercise; provided, however, that each holder may increase or decrease such beneficial ownership limitation by giving 61 days' notice to us, but not to any percentage in excess of 19.99%. If the holder is not permitted to exercise a Private Placement Warrant for shares of our common stock due to the foregoing limitation, then the holder may exercise the Private Placement Warrant for an equivalent number of Pre-Funded Warrants with an exercise price of \$0.001. If there is no effective registration statement at the time of exercise, the Private Placement Warrants may be exercised on cashless basis.

As of December 31, 2022, 50,925,365 Private Placement Warrants were outstanding and remain unexercised.

Class C Warrants

In connection with our issuance of securities in a public offering that closed on December 9, 2022, we issued 65,525,894 Class C Warrants, each of which are exercisable at two Class C Warrants for one share of our common stock or Pre-Funded Warrants to purchase shares of our common stock. The Class C Warrants have an exercise price of \$1.50 per set of two Class C warrants, expire on December 9, 2027 and were immediately exercisable upon issuance, provided that a holder is prohibited, subject to certain exceptions, from exercising the Class C Warrant for shares of our common stock to the extent that immediately after giving effect to such exercise, such holder, together with its affiliates and other attribution parties, would own more than 4.99% of the total number of shares of our common stock then issued and outstanding, which percentage may be changed at the holder's election to a higher or lower percentage not in excess of 9.99% upon 61 days' prior notice from the holder to us subject to the terms of the Class C Warrants. If a holder is not permitted to exercise a Class C Warrant for shares of our common

stock due to the foregoing limitation, then the holder may exercise the Class C Warrant for an equivalent number of Pre-Funded Warrants with an exercise price of \$0.001. If there is no effective registration statement at the time of exercise, the Class C Warrants may be exercised cashlessly.

As of December 31, 2022, 65,525,894 Class C Warrants are outstanding and remain unexercised.

Pre-Funded Warrants

As of December 31, 2022, there were 24,150,977 Pre-Funded Warrants to purchase shares of our common stock at an exercise price of \$0.001 per share as to 21,326,279 Pre-Funded Warrants outstanding and an exercise price of \$0.01 per share as to 2,824,698 Pre-Funded Warrants outstanding. The Pre-Funded Warrants are exercisable, subject to certain beneficial ownership restrictions, at any time after their original issuance and will not expire.

Anti-Takeover Provisions

Section 203 of the Delaware General Corporation Law

We are subject to Section 203 of the DGCL, which prohibits a Delaware corporation from engaging in any business combination with any interested stockholder for a period of three years after the date that such stockholder became an interested stockholder, with the following exceptions:

- before such date, the board of directors of the corporation approved either the business combination or the transaction that resulted in the stockholder becoming an interested stockholder;
- upon completion of the transaction that resulted in the stockholder becoming an interested stockholder, the interested stockholder owned at least 85% of the voting stock of the corporation outstanding at the time the transaction began, excluding for purposes of determining the voting stock outstanding, but not the outstanding voting stock owned by the interested stockholder, those shares owned (i) by persons who are directors and also officers and (ii) employee stock plans in which employee participants do not have the right to determine confidentially whether shares held subject to the plan will be tendered in a tender or exchange offer; or
- on or after such date, the business combination is approved by the board of directors and authorized at an annual or special meeting of the stockholders, and not by written consent, by the affirmative vote of at least 66 2/3% of the outstanding voting stock that is not owned by the interested stockholder.

In general, Section 203 defines a “business combination” to include the following:

- any merger or consolidation involving the corporation and the interested stockholder;
- any sale, transfer, pledge or other disposition of 10% or more of the assets of the corporation involving the interested stockholder;
- subject to certain exceptions, any transaction that results in the issuance or transfer by the corporation of any stock of the corporation to the interested stockholder;
- any transaction involving the corporation that has the effect of increasing the proportionate share of the stock or any class or series of the corporation beneficially owned by the interested stockholder; or
- the receipt by the interested stockholder of the benefit of any loans, advances, guarantees, pledges or other financial benefits by or through the corporation.

In general, Section 203 defines an “interested stockholder” as an entity or person who, together with the person’s affiliates and associates, beneficially owns, or within three years prior to the time of determination of interested stockholder status did own, 15% or more of the outstanding voting stock of the corporation.

Staggered Board

Our restated certificate and by-laws divide our board of directors into three classes with staggered three year terms. In addition, our restated certificate and by-laws provide that directors may be removed only for cause and only by the affirmative vote of the holders of 75% of our shares of capital stock present in person or by proxy and entitled to vote. Under our restated certificate and by-laws, any vacancy on our

board of directors, including a vacancy resulting from an enlargement of our board of directors, may be filled only by vote of a majority of our directors then in office. Furthermore, our restated certificate provides that the authorized number of directors may be changed only by the resolution of our board of directors, subject to the rights of any holders of preferred stock to elect directors. The classification of our board of directors and the limitations on the ability of our stockholders to remove directors, change the authorized number of directors and fill vacancies could make it more difficult for a third party to acquire, or discourage a third party from seeking to acquire, control of us.

Authorized but Unissued Shares

The authorized but unissued shares of common stock are available for future issuance without stockholder approval, subject to any limitations imposed by the listing standards of any exchange on which our shares are listed. These additional shares may be used for a variety of corporate finance transactions, acquisitions and employee benefit plans. The existence of authorized but unissued and unreserved common stock could make more difficult or discourage an attempt to obtain control of us by means of a proxy contest, tender offer, merger or otherwise.

Special Meeting of Stockholders; Advance Notice Requirements for Stockholder Proposals and Director Nominations; Stockholder Action

Our restated certificate and restated by-laws provide that any action required or permitted to be taken by our stockholders at an annual meeting or special meeting of stockholders may only be taken if it is properly brought before such meeting and may not be taken by written action in lieu of a meeting. Our restated certificate and our restated by-laws also provide that, except as otherwise required by law, special meetings of the stockholders can only be called by the chairman of our board of directors, our chief executive officer or our board of directors. In addition, our restated by-laws establish an advance notice procedure for stockholder proposals to be brought before an annual meeting of stockholders, including proposed nominations of candidates for election to our board of directors. Stockholders at an annual meeting may only consider proposals or nominations specified in the notice of meeting or brought before the meeting by or at the direction of our board of directors, or by a stockholder of record on the record date for the meeting who is entitled to vote at the meeting and who has delivered timely written notice in proper form to our secretary of the stockholder's intention to bring such business before the meeting. These provisions could have the effect of delaying until the next stockholder meeting stockholder actions that are favored by the holders of a majority of our outstanding voting securities. These provisions also could discourage a third party from making a tender offer for our common stock because even if the third party acquired a majority of our outstanding voting stock, it would be able to take action as a stockholder, such as electing new directors or approving a merger, only at a duly called stockholders meeting and not by written consent.

Super Majority Voting

The DGCL provides generally that the affirmative vote of a majority of the shares entitled to vote on any matter is required to amend a corporation's certificate of incorporation or by-laws, unless a corporation's certificate of incorporation or by-laws, as the case may be, require a greater percentage. Our amended and restated by-laws may be amended or repealed by a majority vote of our board of directors or the affirmative vote of the holders of at least 75% of the votes that all of our stockholders would be entitled to cast in any election of directors. In addition, the affirmative vote of the holders of at least 75% of the votes that all of our stockholders would be entitled to cast in any election of directors is required to amend or repeal or to adopt any provisions inconsistent with certain of the provisions of our restated certificate.

Exclusive Forum Selection

Our restated certificate of incorporation provides that, unless we consent in writing to the selection of an alternative forum, the Court of Chancery of the State of Delaware shall be the sole and exclusive forum for (1) any derivative action or proceeding brought on behalf of our company, (2) any action asserting a claim of breach of a fiduciary duty owed by any of our directors, officers, employees or stockholders to our company or our stockholders, (3) any action asserting a claim arising pursuant to any provision of the General Corporation Law of the State of Delaware or as to which the General Corporation Law of the State of Delaware confers jurisdiction on the Court of Chancery of the State of Delaware, or (4) any action asserting a claim arising pursuant to any provision of our restated certificate or restated by-laws (in each case, as they may be amended from time to time) or governed by the internal affairs doctrine. This exclusive forum provision would not apply to suits brought to enforce any liability or duty created by the

Securities Act or the Exchange Act or any other claim for which the federal courts have exclusive jurisdiction. To the extent that any such claims may be based upon federal law claims, Section 27 of the Exchange Act creates exclusive federal jurisdiction over all suits brought to enforce any duty or liability created by the Exchange Act or the rules and regulations thereunder. Furthermore, Section 22 of the concurrent jurisdiction for federal and state courts over all suits brought to enforce any duty or liability created by the Securities Act or the rules and regulations thereunder. Although our restated certificate contains the choice of forum provision described above, it is possible that a court could rule that such a provision is inapplicable for a particular claim or action or that such provision is unenforceable.

Transfer Agent and Registrar

The transfer agent and registrar for our common stock is Computershare Trust Company, N.A., with offices at 250 Royall Street, Canton, Massachusetts 02021.

Listing on Nasdaq

Our common stock is listed on the Nasdaq Capital Market under the symbol "XFOR."

X4 PHARMACEUTICALS, INC.
DIRECTOR COMPENSATION POLICY
(Last modified: March 2, 2023)

The Board of Directors (the “Board”) of X4 Pharmaceuticals, Inc. (the “Company”), has approved the following Director Compensation Policy under which the Company’s non-employee directors shall receive the following compensation for their service as members of the Board.

Director Compensation

Our goal is to provide compensation for our non-employee directors in a manner that enables us to attract and retain outstanding director candidates and reflects the substantial time commitment necessary to oversee the Company’s affairs. We also seek to align the interests of our directors and our stockholders and we have chosen to do so by compensating our non-employee directors with a mix of cash and equity-based compensation.

Cash Compensation

A \$35,000 annual cash retainer will be paid to each non-employee director for his or her service on the Board, and additional annual cash retainer(s) will be paid to the chairperson of the Board (if one is then appointed), each non-employee director chairperson of a committee of the Board, and each non-employee director serving as a member of a committee of the Board (other than as chairperson of such committee) as follows:

	Additional Annual Cash Retainer Amount for Chairperson	Additional Annual Cash Retainer Amount for Member
Board of Directors	\$ 40,000	—
Audit Committee	\$ 15,000	\$ 7,500
Compensation Committee	\$ 10,000	\$ 5,000
Nominating and Corporate Governance Committee	\$ 8,000	\$ 4,000

The foregoing cash retainer amounts will be payable in arrears in four equal quarterly installments on the last day of each quarter, provided that the amount of such payment will be prorated for any portion of such quarter that the director is not serving on our Board, on such committee or in such position.

Equity Compensation

Initial Grants. Upon initial election to our Board, such non-employee director will be granted, automatically and without the need for any further action by the Board, an initial equity award of 90,000 restricted stock units (“RSUs”) with respect to shares of our common stock. The initial award shall vest over a three-year period, with one-third of the initial award vesting on each of the first, second and third anniversaries of the grant date of the award, in each case, subject to the director’s continued service as a director, employee or consultant with the Company through each applicable vesting date. The vesting of such award shall accelerate as to 100% of the award upon a change in control of the Company.

Annual Grants. Each continuing non-employee director who has served as a member of our Board for at least six months prior to the date of our annual meeting of stockholders for a particular year will be granted, automatically and without the need for any further action by the Board, an equity award on the date of our annual meeting of stockholders for such year equal to 45,000 RSUs with respect to shares of our common stock. The annual award shall vest in full on the one-year anniversary of the grant date of the award (or, if earlier, the date of our next annual meeting of stockholders following the date of grant of the award), subject to the director’s continued service as a director, employee or consultant with the Company through such vesting date. The vesting of such award shall accelerate as to 100% of the award upon a change in control of the Company.

The foregoing share amounts shall be automatically adjusted in the event of any stock split, reverse stock split, stock dividend, recapitalization, combination of shares, reclassification of shares, spin-off or other similar change in

capitalization or event effecting our common stock, or any distribution to holders of our common stock other than an ordinary cash dividend.

The initial awards and the annual awards shall be subject to the terms and conditions of our Amended and Restated 2017 Equity Incentive Plan, as may be amended from time to time, or any successor plan, and the terms of the RSU award agreements entered into with each director in connection with such awards.

Expenses

Upon presentation of documentation of such expenses reasonably satisfactory to the Company, each non-employee director shall be reimbursed for his or her reasonable out-of-pocket business expenses incurred in connection with attending meetings of the Board and committees thereof or in connection with other business related to the Board, and each non-employee director shall also be reimbursed for his or her reasonable out-of-pocket business expenses authorized by the Board or a committee of the Board that are incurred in connection with attendance at various conferences or meetings with management of the Company, in accordance with the Company's travel policy, as it may be in effect from time to time.



EXECUTIVE EMPLOYMENT AGREEMENT

THIS EXECUTIVE EMPLOYMENT AGREEMENT (this "Agreement") is entered into as of November 14, 2022, (the "Effective Date"), by and between X4 Pharmaceuticals, Inc. (the "Company"), and Murray Stewart ("Executive") (collectively referred to as the "Parties" or individually referred to as a "Party").

RECITALS

WHEREAS, the Company desires to employ Executive as its Chief Medical Officer, and to enter into an agreement embodying the terms of such employment;

WHEREAS, Executive desires to accept such employment and enter into such an agreement.

AGREEMENT

NOW, THEREFORE, in consideration of the premises and mutual covenants herein and for other good and valuable consideration, the Parties agree as follows:

1. Duties and Scope of Employment.

(a) Positions and Duties. As of November 14, 2022 (the "Start Date"), Executive will serve as Chief Medical Officer of the Company. Executive will render such business and professional services in the performance of Executive's duties, consistent with Executive's position within the Company, as shall reasonably be assigned to Executive by the Company's Chief Executive Officer. The period of Executive's at-will employment under the terms of this Agreement is referred to herein as the "Employment Term."

(b) Obligations. During the Employment Term, Executive will perform Executive's duties faithfully and to the best of Executive's ability and will devote Executive's full business efforts and time to the Company. For the duration of the Employment Term, Executive agrees not to actively engage in any other employment, occupation or consulting activity, for any direct or indirect remuneration, that may create a conflict of interest or interfere with Executive's duties to the Company, without the prior approval of the Company's Chief Executive Officer

(c) No Conflicts. As a condition of Executive's employment, Executive certifies to the Company that: (a) Executive is free to enter into and fully perform the duties of Executive's position; (b) Executive is not subject to any employment, confidentiality, non-competition or other agreement that would restrict Executive's performance for the Company; (c) Executive's signing this Agreement does not violate any order, judgment or injunction applicable to Executive, or conflict with or breach any agreement to which Executive is a party or by which Executive is bound; and (d) all facts Executive has presented to the Company are accurate and true, including, but not limited to, all oral and written statements Executive has made (including those pertaining to Executive's education, training, qualifications, licensing and prior work experience) in any job application, resume, *c.v.*, interview or discussion with the Company.

2. At-Will Employment. The parties agree that Executive's employment with the Company will be "at-will" employment and may be terminated at any time with or without cause or notice, for any reason or no

reason. Executive understands and agrees that neither Executive's job performance nor promotions, commendations, bonuses or the like from the Company give rise to or in any way serve as the basis for modification, amendment, or extension, by implication or otherwise, of Executive's employment with the Company.

3. Compensation.

(a) Base Salary. During the Employment Term, the Company will initially pay Executive as compensation for Executive's services a base salary at a rate of \$508,500.00 per year, as modified from time to time at the discretion of the Company (the "Base Salary"). The Base Salary will be paid in regular installments in accordance with the Company's normal payroll practices (subject to required withholding). Any increase or decrease in Base Salary (together with the then existing Base Salary) shall serve as the "Base Salary" for future employment under this Agreement. The first and last payment will be adjusted, if necessary, to reflect a commencement or termination date other than the first or last working day of a pay period.

(b) Annual Bonus. For 2022 and 2023, Executive will be eligible to earn an annual discretionary bonus with a target amount equal to 40% of the Base Salary ("Target Bonus"). The amount of the Target Bonus, if any, will be (i) prorated based on the total days the Executive is employed during the calendar year, (ii) determined in the sole discretion of the Company, and (iii) based, in part, on Executive's performance and the performance of the Company during the calendar year. For the 2022 Target Bonus, the Company will pay Executive the Target Bonus, if any, by no later than March 15th of the following calendar year. For the 2023 Target Bonus, the Company will pay Executive the Target Bonus, if any, on the first regular payroll date following the date that Executive's employment is terminated by the Company or on the first regular payroll date following the end of the Notice Period (as defined below) if Executive Resigns.

4. Employee Benefits. During the Employment Term, Executive may take advantage of various benefits offered by the Company, such as group medical insurance, dental insurance, short-term disability, long-term disability and the Company's 401(k) plan. Executive will also be entitled to fifteen (15) days of paid time off per year, as well as two (2) personal days and twelve (12) paid holidays, exclusive of any sick days Executive may need. These benefits may be modified or changed from time to time at the sole discretion of the Company. The details of the Company's full benefit offerings can be found in its Employee Handbook.

5. Business Expenses. During the Employment Term, the Company will reimburse Executive for reasonable business travel, entertainment or other business expenses incurred by Executive in the furtherance of or in connection with the performance of Executive's duties hereunder, in accordance with the Company's expense reimbursement policy as in effect from time to time. All reimbursements provided under this Agreement will be made or provided in accordance with the requirements of Section 409A of the Internal Revenue Code ("Section 409A") and the rules and regulations thereunder, including, where applicable, the requirement that (i) any reimbursement is for expenses incurred during Executive's lifetime (or during a shorter period of time specified in this Agreement); (ii) the amount of expenses eligible for reimbursement during a calendar year may not affect the expenses eligible for reimbursement in any other calendar year; (iii) the reimbursement of an eligible expense shall be made no later than the last day of the calendar year following the year in which the expense is incurred; and (iv) the right to reimbursement or in kind benefits is not subject to liquidation or exchange for another benefit.

6. Termination of Employment.

(a) Effectiveness. Notwithstanding any other provision of this Agreement, the Company may terminate Executive's employment at any time, which shall be effective on the date the Company gives notice to Employee of such termination in accordance with this Agreement unless otherwise agreed by the Parties. Executive may resign from Executive's employment with the Company, provided that Executive provide at least four (4) weeks prior written notice (the "Notice Period"). Such resignation shall be effective upon the expiration of the Notice Period. In the event that the Company accelerates the effective date of a resignation, such acceleration will result in the date selected by the Company serving as Executive's final day of employment without any obligation for the Company to pay Executive's Base Salary for any days that remain in the Notice Period after such date. Executive's employment will terminate automatically upon Executive's Death or, upon fourteen (14) days prior written notice from the Company, in the event of Disability.

(b) Effect of Termination. Upon any termination of Executive's employment, including by the Company or based on Executive's resignation or based on Executive's death or Disability, Executive shall be entitled to: (i) Executive's Base Salary through the effective date of termination; (ii) the right to continue health care benefits under Title X of the Consolidated Omnibus Budget Reconciliation Act of 1985, as amended ("COBRA"), at Executive's cost, to the extent required and available by law; (iii) reimbursement of expenses for which Executive is entitled to be reimbursed pursuant to Section 5 above, but for which Executive has not yet been reimbursed; and (iv) no other severance or benefits of any kind, unless required by law or pursuant to any other written Company plans or policies, as then in effect.

(c) Disability. For purposes of this Agreement, "Disability" means that Executive, at the time notice is given, has been unable to substantially perform Executive's duties under this Agreement for not less than one-hundred and twenty (120) work days within a twelve (12) consecutive month period as a result of Executive's incapacity due to a physical or mental condition and, if reasonable accommodation is required by law, after any reasonable accommodation.

7. Company Matters.

(a) Proprietary Information and Inventions. In connection with Executive's employment with the Company, Executive will receive and have access to Company confidential information and trade secrets. Accordingly, enclosed with this Agreement is a Confidentiality, Non-Solicitation, and Intellectual Property Agreement (the "Confidential Information Agreement") which contains restrictive covenants and prohibits unauthorized use or disclosure of the Company's confidential information and trade secrets, among other obligations. Executive agrees to review the Confidential Information Agreement and only sign it after careful consideration.

(b) Resignation on Termination. On termination of Executive's employment, regardless of the reason for such termination, Executive shall immediately (and with contemporaneous effect) resign any directorships, offices or other positions that Executive may hold in the Company or any affiliate, unless otherwise agreed in writing by the Parties.

(c) Notification of New Employer. In the event that Executive leaves the employ of the Company, Executive grants consent to notification by the Company to Executive's new employer about Executive's rights and obligations under this Agreement and the Confidential Information Agreement. Company agrees not to notify Executive's new employer unless it has a reasonable belief that Executive has violated or intends to violate a provision of the Confidential Information Agreement.

8. Arbitration. To ensure the timely and economical resolution of disputes that may arise in connection with Executive's employment with the Company, Executive and the Company agree that any and all disputes, claims, or causes of action arising from or relating to the enforcement, breach, performance, negotiation, execution, or interpretation of this Agreement, Confidential Information Agreement, or Executive's employment, or the termination of Executive's employment, including but not limited to the Massachusetts Antidiscrimination Act, Mass. Gen. Laws ch.151B and the Massachusetts Wage Act, Mass. Gen. Laws ch. 149,

and any other statutory claims, will be resolved pursuant to the Federal Arbitration Act, 9 U.S.C. §1-16, and to the fullest extent permitted by law, by final, binding and confidential arbitration by a single arbitrator conducted in Boston, Massachusetts by Judicial Arbitration and Mediation Services Inc. (“**JAMS**”) under the then applicable JAMS rules (at the following web address: <https://www.jamsadr.com/rules-employment-arbitration/>); provided, however, this arbitration provision shall not apply to sexual harassment claims to the extent prohibited by applicable law. A hard copy of the rules will be provided to Executive upon request. **By agreeing to this arbitration procedure, both Executive and the Company waive the right to resolve any such dispute through a trial by jury or judge or administrative proceeding.** In addition, all claims, disputes, or causes of action under this Section, whether by Executive or the Company, must be brought in an individual capacity, and shall not be brought as a plaintiff (or claimant) or class member in any purported class or representative proceeding, nor joined or consolidated with the claims of any other person or entity. The Arbitrator may not consolidate the claims of more than one person or entity, and may not preside over any form of representative or class proceeding. To the extent that the preceding sentences regarding class claims or proceedings are found to violate applicable law or are otherwise found unenforceable, any claim(s) alleged or brought on behalf of a class shall proceed in a court of law rather than by arbitration. The Company acknowledges that Executive will have the right to be represented by legal counsel at any arbitration proceeding. Questions of whether a claim is subject to arbitration under this Agreement shall be decided by the arbitrator. Likewise, procedural questions which grow out of the dispute and bear on the final disposition are also matters for the arbitrator. The arbitrator shall: (a) have the authority to compel adequate discovery for the resolution of the dispute and to award such relief as would otherwise be permitted by law; (b) issue a written arbitration decision, to include the arbitrator’s essential findings and conclusions and a statement of the award; and (c) be authorized to award any or all remedies that Executive or the Company would be entitled to seek in a court of law. Executive and the Company shall equally share all JAMS’ arbitration fees. Except as modified in the Confidential Information Agreement, each party is responsible for its own attorneys’ fees. Nothing in this Agreement is intended to prevent either Executive or the Company from obtaining injunctive relief in court to prevent irreparable harm pending the conclusion of any such arbitration. Any awards or orders in such arbitrations may be entered and enforced as judgments in the federal and state courts of any competent jurisdiction. To the extent applicable law prohibits mandatory arbitration of sexual harassment claims, in the event you intend to bring multiple claims, including a sexual harassment claim, the sexual harassment may be publicly filed with a court, while any other claims will remain subject to mandatory arbitration.

9. **Assignment.** This Agreement will be binding upon and inure to the benefit of (a) the heirs, executors and legal representatives of Executive upon Executive's death and (b) any successor of the Company. Any such successor of the Company will be deemed substituted for the Company under the terms of this Agreement for all purposes. For this purpose, “successor” means any person, firm, corporation or other business entity which at any time, whether by purchase, merger or otherwise, directly or indirectly acquires all or substantially all of the assets or business of the Company. None of the rights of Executive to receive any form of compensation payable pursuant to this Agreement may be assigned or transferred except by will or the laws of descent and distribution. Any other attempted assignment, transfer, conveyance or other disposition of Executive’s right to compensation or other benefits will be null and void.

10. **Notices.** All notices, requests, demands and other communications called for under this Agreement shall be in writing and shall be delivered via e-mail, personally by hand or by courier, mailed by United States first-class mail, postage prepaid, or sent by facsimile directed to the Party to be notified at the address or facsimile number indicated for such Party on the signature page to this Agreement, or at such other address or facsimile number as such Party may designate by ten (10) days’ advance written notice to the other Parties hereto. All such notices and other communications shall be deemed given upon personal delivery, three (3) days after the date of mailing, or upon confirmation of facsimile transfer or e-mail. Notices sent via e-mail under this Section shall be sent to either the e-mail address in this Agreement, or for e-mails sent by the Company to Executive, to the last e-mail address on file with the Company.

11. **Severability.** In the event that any provision hereof becomes or is declared by a court of competent jurisdiction to be illegal, unenforceable or void, this Agreement will continue in full force and effect without said provision.

12. Integration. This Agreement, together with the Plan and related agreements, and the Confidential Information Agreement represents the entire agreement and understanding between the parties as to the subject matter herein and supersedes all prior or contemporaneous agreements whether written or oral. No waiver, alteration, or modification of any of the provisions of this Agreement will be binding unless in writing and signed by duly authorized representatives of the parties hereto.

13. Tax Withholding. All payments made pursuant to this Agreement will be subject to withholding of applicable taxes.

14. Waiver. No Party shall be deemed to have waived any right, power or privilege under this Agreement or any provisions hereof unless such waiver shall have been duly executed in writing and acknowledged by the Party to be charged with such waiver. The failure of any Party at any time to insist on performance of any of the provisions of this Agreement shall in no way be construed to be a waiver of such provisions, nor in any way to affect the validity of this Agreement or any part hereof. No waiver of any breach of this Agreement shall be held to be a waiver of any other subsequent breach

15. Governing Law. This Agreement will be governed by the laws of the Commonwealth of Massachusetts (with the exception of its conflict of laws provisions).

16. Acknowledgment. Executive acknowledges that Executive has had the opportunity to discuss this matter with and obtain advice from Executive's legal counsel, has had sufficient time to, and has carefully read and fully understands all the provisions of this Agreement, and is knowingly and voluntarily entering into this Agreement.

17. Counterparts. This Agreement may be executed in multiple counterparts, each of which shall be deemed to be an original, and all such counterparts shall constitute but one instrument.

18. Effect of Headings. The section and subsection headings contained herein are for convenience only and shall not affect the construction hereof.

19. Construction of Agreement. This Agreement has been negotiated by the respective Parties, and the language shall not be construed for or against either Party.

20. Section 409A.

(a) Notwithstanding anything to the contrary in this Agreement, no severance pay or benefits to be paid or provided to Executive, if any, pursuant to this Agreement, when considered together with any other severance payments or separation benefits that are considered deferred compensation under Section 409A (together, the "Deferred Compensation Separation Benefits") will be paid or otherwise provided until Executive has a "separation from service" within the meaning of Section 409A.

(b) Notwithstanding anything to the contrary in this Agreement, if Executive is a "specified employee" within the meaning of Section 409A at the time of Executive's termination (other than due to death), then the Deferred Compensation Separation Benefits that are payable within the first six (6) months following Executive's separation from service, will become payable on the first payroll date that occurs on or after the date six (6) months and one (1) day following the date of Executive's separation from service. All subsequent Deferred Compensation Separation Benefits, if any, will be payable in accordance with the payment schedule applicable to each payment or benefit. Notwithstanding anything herein to the contrary, if Executive dies following Executive's separation from service, but prior to the six (6) month anniversary of the separation from service, then any payments delayed in accordance with this paragraph will be payable in a lump sum as soon as administratively practicable after the date of Executive's death and all other Deferred Compensation Separation Benefits will be payable in accordance with the payment schedule applicable to each payment or benefit. Each payment and benefit payable under this Agreement is intended to constitute separate payments for purposes of Section 1.409A-2(b)(2) of the Treasury Regulations.

(c) Any amount paid under this Agreement that satisfies the requirements of the “short-term deferral” rule set forth in Section 1.409A-1(b)(4) of the Treasury Regulations will not constitute Deferred Compensation Separation Benefits for purposes of clause (a) above.

(d) Any amount paid under this Agreement that qualifies as a payment made as a result of an involuntary separation from service pursuant to Section 1.409A-1(b)(9)(iii) of the Treasury Regulations that does not exceed the Section 409A Limit will not constitute Deferred Compensation Separation Benefits for purposes of clause (a) above. For purposes of this Agreement, “Section 409A Limit” will mean the lesser of two (2) times: (i) Executive’s annualized compensation based upon the annual rate of pay paid to Executive during the Executive’s taxable year preceding Executive’s taxable year of Executive’s termination of employment as determined under Treasury Regulation Section 1.409A-1(b)(9)(iii)(A)(1) and any Internal Revenue Service guidance issued with respect thereto; or (ii) the maximum amount that may be taken into account under a qualified plan pursuant to Section 401(a)(17) of the Internal Revenue Code for the year in which Executive’s employment is terminated.

The foregoing provisions are intended to comply with the requirements of Section 409A so that none of the severance payments and benefits to be provided hereunder will be subject to the additional tax imposed under Section 409A, and any ambiguities herein will be interpreted to so comply. The Company and Executive agree to work together in good faith to consider amendments to this Agreement and to take such reasonable actions which are necessary, appropriate or desirable to avoid imposition of any additional tax or income recognition prior to actual payment to Executive under Section 409A.

IN WITNESS WHEREOF, each of the Parties has executed this Agreement as of the day and year first above written.

“COMPANY”

X4 PHARMACEUTICALS, INC.

By: /s/ Paula Ragan

Paula Ragan, PhD, CEO

Address:
X4 Pharmaceuticals, Inc.
61 North Beacon Street, 4th Floor
Boston, MA 02134

Attn:

Email:

“EXECUTIVE”

MURRAY STEWART

/s/ Murray Stewart
Executive Name

Address:

Email:

Enclosure
Confidentiality, Non-Solicitation, and Intellectual Property Agreement

**X4 PHARMACEUTICALS, INC.
EXECUTIVE EMPLOYMENT AGREEMENT
SIGNATURE PAGE**

Certain schedules and exhibits have been omitted from this Exhibit pursuant to Item 601(a)(5) of Regulation S-K. X4 Pharmaceuticals, Inc. will furnish a copy of any omitted schedule or exhibit to the U.S. Securities and Exchange Commission or its staff upon request.

SECOND AMENDED AND RESTATED LOAN AND SECURITY AGREEMENT

THIS SECOND AMENDED AND RESTATED LOAN AND SECURITY AGREEMENT is made and dated as of January 6, 2023 and is entered into by and among X4 PHARMACEUTICALS, INC. a Delaware corporation (formerly known as Arsanis, Inc., the “Company”), and each of its Qualified Subsidiaries, including without limitation X4 THERAPEUTICS, INC. (formerly known as X4 Pharmaceuticals, Inc., “Therapeutics”), the several banks and other financial institutions or entities from time to time parties to this Agreement (each, a “Lender,” and collectively, referred to as the “Lenders”) and HERCULES CAPITAL, INC., a Maryland corporation, in its capacity as administrative agent and collateral agent for itself and the Lenders (in such capacity, the “Agent”). The Company and Therapeutics are hereinafter referred to each, as a “Borrower,” and jointly as “Borrower.”

RECITALS

A. Therapeutics, as Borrower, the Lenders party thereto and Agent entered into that certain Loan and Security Agreement, dated as of October 19, 2018 (as amended by that certain Amendment No. 1 to Loan and Security Agreement, dated as of December 11, 2018 “Original Agreement”);

B. Effective as of March 13, 2019, Therapeutics merged with and into the Company’s wholly owned subsidiary known as Artemis AC Corp. and was the surviving corporation of the merger with Artemis AC Corp;

C. The Company wished to become a Borrower, and Borrower, Lenders and Agent entered into an Amended and Restated Loan and Security Agreement effective as of June 27, 2019 (as subsequently amended from time to time, the “Original A&R LSA”) which amended and restated the Original Agreement in its entirety, without constituting a novation;

D. Borrower has now requested the Lenders to make available to Borrower a loan in an aggregate principal amount of up to Thirty-Two Million Five Hundred Thousand Dollars (\$32,500,000.00) (the “Term Loan”); and

E. The Lenders are willing to make the Term Loan on the terms and conditions set forth in this Agreement.

AGREEMENT

NOW, THEREFORE, Borrower, Agent and the Lenders agree that the Original A&R LSA is hereby amended and restated in its entirety as follows:

SECTION 1. DEFINITIONS AND RULES OF CONSTRUCTION

1.1 Unless otherwise defined herein, the following capitalized terms shall have the following meanings:

“Account Control Agreement(s)” means any agreement entered into by and among the Agent, Borrower and a third party bank or other institution (including a Securities Intermediary) in which Borrower maintains a Deposit Account or an account holding Investment Property and which perfects Agent’s first priority security interest in the subject account or accounts.

“ACH Authorization” means the ACH Debit Authorization Agreement in substantially the form of Exhibit H, which account numbers shall be redacted for security purposes if and when filed publicly by the Borrower.

“Advance(s)” means a Term Loan Advance.

“Advance Date” means the funding date of any Advance.

“Advance Request” means a request for an Advance submitted by Borrower to Agent in substantially the form of Exhibit A, which account numbers shall be redacted for security purposes if and when filed publicly by the Borrower.

“Affiliate” means, with respect to any person, (a) any Person that directly or indirectly controls, is controlled by, or is under common control with the Person in question, (b) any Person directly or indirectly owning, controlling or holding with power to vote ten percent (10%) or more of the outstanding voting securities of such Person, or (c) any Person ten percent (10%) or more of whose outstanding voting securities are directly or indirectly owned, controlled or held by such Person with power to vote such securities. As used in the definition of “Affiliate,” the term “control” means the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of a Person, whether through ownership of voting securities, by contract or otherwise.

“Agent” has the meaning given to it in the preamble to this Agreement.

“Agreement” means this Second Amended and Restated Loan and Security Agreement, as amended from time to time.

“All Source Cash Proceeds” means unrestricted (including, not subject to any redemption, clawback, escrow or similar encumbrance or restriction) net Cash proceeds raised from one or more bona fide equity financings (which, for the avoidance of doubt, shall include cash warrant exercises), Subordinated Indebtedness, convertible Indebtedness, at-the-market (ATM) financings, upfront proceeds from corporate transactions, strategic partnerships and/or new business development transactions permitted under this Agreement, and/or Borrower’s monetization of a Pediatric Review Voucher (PRV), subject to verification by Agent (including supporting documentation reasonably requested by Agent), but excluding any Cash proceeds from the Loan.

“Amortization Date” means October 1, 2024; provided however, if the Interest Only Extension Conditions are satisfied, then January 1, 2026.

“Anti-Corruption Laws” shall mean all laws, rules, and regulations of any jurisdiction applicable to Borrower or any of its Affiliates from time to time concerning or relating to bribery or corruption, including without limitation the United States Foreign Corrupt Practices Act of 1977, as amended, the UK Bribery Act 2010 and other similar legislation in any other jurisdictions.

“Anti-Terrorism Laws” means any laws, rules, regulations or orders relating to terrorism or money laundering, including without limitation Executive Order No. 13224 (effective September 24, 2001), the USA PATRIOT Act, the laws comprising or implementing the Bank Secrecy Act, and the laws administered by OFAC.

“Approval Milestone” means that the FDA has approved the sale and marketing of mavoxixafor for the treatment to patients with Warts, Hypogammaglobulinemia, Infections and Myelokathexis (WHIM syndrome) with a label claim that is generally consistent with that sought in Borrower’s New Drug Application filing, subject to Agent’s reasonable verification.

“Approval Milestone Date” means the date on which Borrower achieves the Approval Milestone.

“Assignee” has the meaning given to it in Section 11.13.

“Blocked Person” means any Person: (a) listed in the annex to, or is otherwise subject to the provisions of, Executive Order No. 13224, (b) a Person owned or controlled by, or acting for or on behalf of, any Person that is listed in the annex to, or is otherwise subject to the provisions of, Executive Order No. 13224, (c) a Person with which any Lender is prohibited from dealing or otherwise engaging in any transaction by any Anti-Terrorism Law, (d) a Person that commits, threatens or conspires to commit or supports “terrorism” as defined in Executive Order No. 13224, or (e) a Person that is named a “specially designated national” or “blocked person” on the most current list published by OFAC or other similar list.

“Borrower Products” means all products, software, service offerings, technical data or technology currently being designed, manufactured or sold by Borrower or which Borrower intends to sell, license, or distribute in the future including any products or service offerings under development, collectively, together with all products, software, service offerings, technical data or technology that have been sold, licensed or distributed by Borrower since its incorporation.

“Business Day” means any day other than Saturday, Sunday and any other day on which banking institutions in the State of California or the Commonwealth of Massachusetts are closed for business.

“Cash” means all cash, cash equivalents and liquid funds.

“Change in Control” means any reorganization, recapitalization, consolidation or merger (or similar transaction or series of related transactions) of the Company, or sale or exchange of outstanding shares (or similar transaction or series of related transactions) of Borrower, in each case in which the holders of the Company’s outstanding shares immediately before consummation of such transaction or series of related transactions do not, immediately after consummation of such transaction or series of related transactions, retain shares representing more than fifty percent (50%) of the voting power of the surviving entity of such transaction or series of related transactions (or the parent of such surviving entity if such surviving entity is wholly owned by such parent), in each case without regard to whether the Company is the surviving entity, or in which the Company ceases to retain shares representing one hundred percent (100%) of the equity interests of X4 Therapeutics, Inc.

“Claims” has the meaning given to it in Section 11.10.

“Closing Date” means the date of this Agreement.

“Code” means the Internal Revenue Code of 1986, as amended.

“Collateral” means the property described in Section 3.

“Common Stock” means the Common Stock, \$0.001 par value per share, of the Company.

“Confidential Information” has the meaning given to it in Section 11.12.

“Conversion Balance” has the meaning given to it in Section 2.2(a).

“Contingent Obligation” means, as applied to any Person, any direct or indirect liability, contingent or otherwise, of that Person with respect to (i) any Indebtedness, lease, dividend, letter of credit or other obligation of another, including any such obligation directly or indirectly guaranteed, endorsed, co-made or discounted or sold with recourse by that Person, or in respect of which that Person is otherwise directly or indirectly liable; (ii) any obligations with respect to undrawn letters of credit, corporate credit cards or merchant services issued for the account of that Person; and (iii) all obligations arising under any interest rate, currency or commodity swap agreement, interest rate cap agreement, interest rate collar agreement, or other agreement or arrangement designated to protect a Person against fluctuation in interest rates, currency exchange rates or commodity prices; provided, however, that the term “Contingent Obligation” shall not include endorsements for collection or deposit in the ordinary course of business, or guaranties of leases that do not constitute Indebtedness. The amount of any Contingent Obligation shall be deemed to be an amount equal to the stated or determined amount of the primary obligation in respect of which such Contingent Obligation is made or, if not stated or determinable, the maximum reasonably anticipated liability in respect thereof as determined by such Person in good faith; provided, however, that such amount shall not in any event exceed the maximum amount of the obligations under the guarantee or other support arrangement.

“Copyright License” means any written agreement granting any right to use any Copyright or Copyright registration, now owneded or hereafter acquired by Borrower or in which Borrower now holds or hereafter acquires any interest.

“Copyrights” means all copyrights, whether registered or unregistered, held pursuant to the laws of the United States of America, any State thereof, or of any other country.

“Deposit Accounts” means any “deposit accounts,” as such term is defined in the UCC, and includes any checking account, savings account, or certificate of deposit.

“Domestic Subsidiary” means any Subsidiary that is not a Foreign Subsidiary.

“Eligible Foreign Subsidiary” means any Foreign Subsidiary other than an Excluded Subsidiary, whose execution of a Joinder Agreement could not result in a material adverse tax consequence to Borrower.

“End of Term Charge” has the meaning given to it in Section 2.6(c).

“End of Term Charge I” has the meaning given to it in Section 2.6(a).

“End of Term Charge II” has the meaning given to it in Section 2.6(b).

“End of Term Charge III” has the meaning given to it in Section 2.6(c).

“Equity Interests” means, with respect to any Person, the capital stock, partnership or limited liability company interest, or other equity securities or equity ownership interests of such Person.

“ERISA” means the Employee Retirement Income Security Act of 1974, as amended, and the regulations promulgated thereunder.

“Event of Default” has the meaning given to it in Section 9.

“Excluded Account” means any “zero balance” deposit account or securities account used exclusively for payroll, employee benefits or employee taxes, the funds of which shall not exceed the amount required to pay the next payroll or other relevant cycle, and identified to the Agent in writing by the Borrower as such.

“Excluded Subsidiary” means X4 Pharmaceuticals (Austria) GmbH.

“Facility Charge” means \$162,500 (representing one-half percent (0.50%) of the maximum amount of the Term Loan), due on the Closing Date.

“FDA” means the U.S. Food and Drug Administration or any successor thereto.

“Financial Statements” has the meaning given to it in Section 7.1.

“Foreign Subsidiary” means any Subsidiary other than a Subsidiary organized under the laws of any state within the United States of America.

“GAAP” means generally accepted accounting principles in the United States of America, as in effect from time to time.

“Indebtedness” means indebtedness of any kind, including (a) all indebtedness for borrowed money or the deferred purchase price of property or services (excluding trade credit entered into in the ordinary course of business due within ninety (90) days), including reimbursement and other obligations with respect to surety bonds and letters of credit, (b) all obligations evidenced by notes, bonds, debentures or similar instruments, (c) all capital lease obligations, (d) equity securities of any Person subject to repurchase or redemption other than at the sole option of such Person and (e) all Contingent Obligations within the meaning of GAAP as in effect on the Closing Date; provided that Indebtedness shall not include endorsements of checks or drafts arising in the ordinary course of business.

“Insolvency Proceeding” is any proceeding by or against any Person under the United States Bankruptcy Code, or any other bankruptcy or insolvency law, including assignments for the benefit of creditors, compositions, extensions generally with its creditors, or proceedings seeking reorganization, arrangement, or other similar relief.

“Intellectual Property” means all of Borrower’s Copyrights; Trademarks; Patents; Licenses; trade secrets and inventions; mask works; Borrower’s applications therefor and reissues, extensions, or renewals thereof; and Borrower’s goodwill associated with any of the foregoing, together with Borrower’s rights to sue for past, present and future infringement of Intellectual Property and the goodwill associated therewith.

“Interest Only Extension Conditions” shall mean satisfaction of each of the following events: (a) no default or Event of Default shall have occurred; (b) Borrower shall have obtained a minimum of \$110,000,000 in All Source Cash Proceeds during the period beginning January 1, 2023 through December 31, 2024; and (c) the Approval Milestone Date shall have occurred on or before December 31, 2024.

“Inventory” means “inventory” as defined in Article 9 of the UCC.

“Investment” means (a) any beneficial ownership (including stock, partnership, limited liability company interests, or other securities) of or in any Person, (b) any loan, advance or capital contribution to any Person, (c) or the acquisition of any asset of another Person not in the ordinary course of business.

“IRS” means the United States Internal Revenue Service.

“Joinder Agreements” means for each Qualified Subsidiary, a completed and executed Joinder Agreement in substantially the form attached hereto as Exhibit G.

“Lender” and “Lenders” have the meaning given to it in the preamble to this Agreement.

“License” means any Copyright License, Patent License, Trademark License or other license of rights or interests.

“Lien” means any mortgage, deed of trust, pledge, hypothecation, assignment for security, security interest, encumbrance, levy, lien or charge of any kind, whether voluntarily incurred or arising by operation of law or otherwise, against any property, any conditional sale or other title retention agreement, and any lease in the nature of a security interest.

“Loan” means the Advances made under this Agreement.

“Loan Documents” means this Agreement, the Notes (if any), the ACH Authorization, the Account Control Agreements, the Joinder Agreements, all UCC Financing Statements, the Pledge Agreements, the Warrants issued in connection with the Original Agreement and any other documents executed in connection with the Secured Obligations or the transactions contemplated hereby, as the same may from time to time be amended, modified, supplemented or restated.

“Market Capitalization” means, as of any date of determination, the product of (a) the number of outstanding shares of Common Stock publicly disclosed in the most recent filing of Company with the Securities and Exchange Commission as outstanding as of such date of determination and (b) the most recent closing price of Company’s Common Stock (as quoted on Bloomberg L.P.’s page or any successor page thereto of Bloomberg L.P. or if such page is not available, any other commercially available source).

“Material Adverse Effect” means a material adverse effect upon: (i) the business, operations, properties, assets or financial condition of Borrower and its Subsidiaries taken as a whole; or (ii) the ability of Borrower to perform or pay the Secured Obligations in accordance with the terms of the Loan Documents, or the ability of Agent or the Lenders to enforce any of its rights or remedies with respect to the Secured Obligations; or (iii) the Collateral or Agent’s Liens on the Collateral or the priority of such Liens.

“Maximum Rate” shall have the meaning assigned to such term in Section 2.3.

“Net Product Revenue” means revenue solely generated from the sale of mavorixafor (as determined in accordance with GAAP), which shall include royalty, profit sharing, co-development and co-promotion-commercialization revenues but shall exclude milestone payments and any other one-time revenue.

“Net Product Revenue Forecast” means for Borrower’s 2025 fiscal year, the forecast of Borrower’s Net Product Revenue based on the financial projections provided to Agent prior to the Closing Date, with the forecast for future years based on projections approved by Borrower’s board of directors in accordance with Section 7.1(h) hereof and reasonably acceptable to Agent.

“New Drug Application” means an application submitted to the FDA pursuant to 21 U.S.C. § 355 seeking authorization to market a new drug in the United States.

“Non-Disclosure Agreement” means that certain Confidential Disclosure Agreement by and between X4 Pharmaceuticals, Inc. and Hercules Capital, Inc. dated as of August 14, 2018.

“Note(s)” means a Term Note.

“OFAC” is the U.S. Department of Treasury Office of Foreign Assets Control.

“OFAC Lists” are, collectively, the Specially Designated Nationals and Blocked Persons List maintained by OFAC pursuant to Executive Order No. 13224, 66 Fed. Reg. 49079 (Sept. 25, 2001) and/or any other list of terrorists or other restricted Persons maintained pursuant to any of the rules and regulations of OFAC or pursuant to any other applicable Executive Orders.

“Original Closing Date” means October 19, 2018.

“Original Agreement” has the meaning given to it in the Recitals.

“Original A&R LSA” has the meaning given to it in the Recitals.

“Original A&R LSA Closing Date” means June 27, 2019.

“Original A&R LSA Term Loans” has the meaning given to it in Section 2.2(a).

“Participant Register” shall have the meaning assigned to such term in Section 11.21.

“Patent License” means any written agreement granting any right with respect to any invention on which a Patent is in existence or a Patent application is pending, in which agreement Borrower now holds or hereafter acquires any interest.

“Patents” means all letters patent of, or rights corresponding thereto, in the United States of America or in any other country, all registrations and recordings thereof, and all applications for letters patent of, or rights corresponding thereto, in the United States of America or any other country.

“Permitted Acquisition” shall mean any acquisition (including by way of merger or exclusive in-licensing arrangements) by Borrower of all or substantially all of the assets of another Person, or of a division or line of business of another Person, or capital stock of another Person, in each case located entirely within the United States of America, which is conducted in accordance with the following requirements:

(a) if such acquisition is of a business or Person, such business or Person is engaged in a line of business similar or related to that of the Borrower or its Subsidiaries;

(b) if such acquisition is structured as a stock acquisition, then the Person so acquired shall either (i) become a wholly-owned Subsidiary of Borrower or of a Subsidiary and

the Borrower shall comply, or cause such Subsidiary to comply, with 7.13 hereof or (ii) such Person shall be merged with and into Borrower (with the Borrower being the surviving entity);

(c) if such acquisition is structured as the acquisition of assets, such assets shall be acquired by Borrower, and shall be free and clear of Liens other than Permitted Liens;

(d) the Borrower shall have delivered to Lender not less than ten (10) nor more than forty five (45) days prior to the date of such acquisition, notice of such acquisition together with pro forma projected financial information, copies of all material documents relating to such acquisition, and historical financial statements for such acquired entity, division or line of business, in each case in form and substance reasonably satisfactory to Lender and demonstrating compliance with the covenants set forth in Section 7 hereof on a pro forma basis as if the acquisition occurred on the first day of the most recent measurement period;

(e) both immediately before and after such acquisition no Default or Event of Default shall have occurred and be continuing; and

(f) the sum of the purchase price of such proposed new acquisition, computed on the basis of total acquisition consideration paid or incurred, or to be paid or incurred (but excluding for such purpose any performance-based milestones, earn-outs, royalties or similar payments), by Borrower with respect thereto, including the amount of Permitted Indebtedness assumed or to which such assets, businesses or business or ownership interest or shares, or any Person so acquired, is subject, shall not be greater than (i) \$5,000,000 for any single acquisition or group of related acquisitions or (ii) \$5,000,000 for all such acquisitions during the term of the Loan.

“Permitted Indebtedness” means: (i) Indebtedness of Borrower in favor of the Lenders or Agent arising under this Agreement or any other Loan Document; (ii) Indebtedness existing on the Closing Date which is disclosed in Schedule 1A; (iii) Indebtedness of up to \$1,000,000 outstanding at any time secured by a Lien described in clause (vii) of the defined term “Permitted Liens,” provided such Indebtedness does not exceed the cost of the Equipment financed with such Indebtedness; (iv) Indebtedness to trade creditors incurred in the ordinary course of business, and Indebtedness incurred in the ordinary course of business with corporate credit cards; (v) Indebtedness that also constitutes a Permitted Investment; (vi) Subordinated Indebtedness; (vii) reimbursement obligations in connection with letters of credit that are secured by Cash and issued on behalf of the Borrower or a Subsidiary thereof in an amount not to exceed \$400,000 at any time outstanding, (viii) other unsecured Indebtedness in a principal amount not to exceed \$300,000 at any time outstanding, (ix) intercompany Indebtedness as long as either (A) each of the Subsidiary obligor and the Subsidiary obligee under such Indebtedness is a Qualified Subsidiary that has executed a Joinder Agreement and (x) extensions, amendments, restatements, refinancings and renewals of any items of Permitted Indebtedness, provided that the principal amount is not increased or the terms modified to impose materially more burdensome terms upon Borrower or its Subsidiary, as the case may be.

“Permitted Investment” means: (i) Investments existing on the Closing Date which are disclosed in Schedule 1B; (ii) (a) marketable direct obligations issued or unconditionally

guaranteed by the United States of America or any agency or any State thereof maturing within one year from the date of acquisition thereof currently having a rating of at least A-2 or P-2 from either Standard & Poor's Corporation or Moody's Investors Services, (b) commercial paper maturing no more than one year from the date of creation thereof and currently having a rating of at least A-2 or P-2 from either Standard & Poor's Corporation or Moody's Investors Service, (c) certificates of deposit issued by any bank with assets of at least \$500,000,000 maturing no more than one year from the date of investment therein, (d) money market accounts, and (e) Investments made pursuant to the investment policy guidelines of the Borrower in effect as of the Closing Date or amended guidelines as approved by Borrower's Board of Directors; (iii) repurchases of stock from current or former employees, directors, or consultants of Borrower under the terms of applicable repurchase agreements at the original issuance price of such securities in an aggregate amount not to exceed \$375,000 in any fiscal year, provided that no Event of Default has occurred and is continuing or would immediately result after giving effect to the repurchases; (iv) Investments consisting of the endorsement of negotiable instruments for deposit or collection or similar transactions in the ordinary course of business; (v) Investments accepted in connection with Permitted Transfers; (vi) Investments (including debt obligations) received in connection with the bankruptcy or reorganization of customers or suppliers and in settlement of delinquent obligations of, and other disputes with, customers or suppliers arising in the ordinary course of Borrower's business; (vii) Investments consisting of notes receivable of, or prepaid royalties and other credit extensions, to customers and suppliers who are not Affiliates, in the ordinary course of business, provided that this subparagraph (vii) shall not apply to Investments of Borrower in any Subsidiary; (viii) Investments consisting of loans not involving the net transfer on a substantially contemporaneous basis of cash proceeds to employees, officers or directors relating to the purchase of capital stock of Borrower pursuant to employee stock purchase plans or other similar agreements approved by Borrower's Board of Directors; (ix) Investments consisting of travel advances, employee relocation loans, and other employee loans and advances in the ordinary course of business in an aggregate amount not to exceed \$375,000 in any fiscal year or \$750,000 during the term hereof; (x) Investments in newly-formed Domestic Subsidiaries, provided that each such Domestic Subsidiary, other than Security Corporation Subsidiary, enters into a Joinder Agreement promptly after its formation by Borrower and execute such other documents as shall be reasonably requested by Agent; (xi) Investments in Foreign Subsidiaries approved in advance in writing by Agent; (xii) so long as no Event of Default has occurred and is continuing, Investments in the Excluded Subsidiary from time to time on an ongoing basis, sufficient to permit the Excluded Subsidiary to operate and conduct its business in the ordinary course; (xiii) joint ventures or strategic alliances in the ordinary course of Borrower's business consisting of the licensing of technology, the development of technology or the providing of technical support, provided that any cash Investments by Borrower do not exceed \$750,000 in the aggregate in any fiscal year; (xiv) Investments in Permitted Acquisitions; (xv) Investments in Security Corporation Subsidiary; and (xvi) additional Investments that do not exceed \$500,000 in the aggregate.

"Permitted Liens" means any and all of the following: (i) Liens in favor of Agent or the Lenders; (ii) Liens existing on the Closing Date which are disclosed in Schedule 1C; (iii) Liens for taxes, fees, assessments or other governmental charges or levies, either not delinquent or being contested in good faith by appropriate proceedings; provided, that Borrower

maintains adequate reserves therefor in accordance with GAAP (to the extent required hereby); (iv) Liens securing claims or demands of materialmen, artisans, mechanics, carriers, warehousemen, landlords and other like Persons arising in the ordinary course of Borrower's business and imposed without action of such parties; provided, that the payment thereof is not yet required; (v) Liens arising from judgments, decrees or attachments in circumstances which do not constitute an Event of Default hereunder; (vi) deposits to secure the performance of obligations not to exceed \$200,000 in the aggregate, and the following deposits, to the extent made in the ordinary course of business: deposits under worker's compensation, unemployment insurance, social security and other similar laws, or to secure the performance of bids, tenders or contracts (other than for the repayment of borrowed money) or to secure indemnity, performance or other similar bonds for the performance of bids, tenders or contracts (other than for the repayment of borrowed money) or to secure statutory obligations (other than Liens arising under ERISA or environmental Liens) or surety or appeal bonds, or to secure indemnity, performance or other similar bonds; (vii) Liens on Equipment or software or other intellectual property constituting purchase money Liens and Liens in connection with capital leases securing Indebtedness permitted in clause (iii) of "Permitted Indebtedness"; (viii) Liens incurred in connection with Subordinated Indebtedness; (ix) leasehold interests in leases or subleases and licenses or sublicenses granted in the ordinary course of business and not interfering in any material respect with the business of the lessor licensor, as applicable; (x) Liens in favor of customs and revenue authorities arising as a matter of law to secure payment of custom duties that are promptly paid on or before the date they become due; (xi) Liens on insurance proceeds securing the payment of financed insurance premiums that are promptly paid on or before the date they become due (provided that such Liens extend only to such insurance proceeds and not to any other property or assets); (xii) statutory and common law rights of set-off and other similar rights as to deposits of cash and securities in favor of banks, other depository institutions and brokerage firms; (xiii) easements, zoning restrictions, rights-of-way and similar encumbrances on real property imposed by law or arising in the ordinary course of business so long as they do not materially impair the value or marketability of the related property; (xiv) (A) Liens on Cash securing obligations permitted under clause (vii) of the definition of Permitted Indebtedness and (B) security deposits in connection with real property leases, the combination of (A) and (B) in an aggregate amount not to exceed \$750,000 at any time; (xv) Liens incurred in connection with the extension, renewal or refinancing of the Indebtedness secured by Liens of the type described in clauses (i) through (xi) above; provided, that any extension, renewal or replacement Lien shall be limited to the property encumbered by the existing Lien and the principal amount of the Indebtedness being extended, renewed, refinanced, modified, amended, restated or amended and restated (as may have been reduced by any payment thereon) does not increase; (xvi) Liens in connection with "precautionary filings" in connection with operating leases of the Equipment that is the subject of such leases; provided that such Liens and collateral descriptions in such precautionary filings are limited to such specific operating leases and not all assets or substantially all assets of the Borrower or any Subsidiary; and (xvii) other Liens securing obligations not to exceed the principal amount of \$500,000 outstanding at any time.

"Permitted Transfers" means (i) sales of Inventory in the ordinary course of business, (ii) non-exclusive outbound licenses and similar arrangements for the use of Intellectual Property in the ordinary course of business, (iii) exclusive licenses for the use of the Intellectual

Property of Borrower or Borrower Products in the field of Immuno-Oncology entered into the ordinary course of business provided that each such license constitutes an arms-length transaction, that could not result in a legal transfer of title of the licensed property, and so long as after giving effect to each such non-exclusive or exclusive license, Borrower and its Subsidiaries retain sufficient rights to use or benefit from the subject Intellectual Property as to enable them to conduct their business in the ordinary course, (iv) dispositions of worn-out, obsolete or surplus Equipment at fair market value in the ordinary course of business, (v) transfers consisting of Permitted Investments or Permitted Liens, (vi) transfers of Cash in the ordinary course of business to the extent not otherwise inconsistent with the terms and conditions of this Agreement, and (vii) other Transfers of assets having a fair market value of not more than \$500,000 in the aggregate in any fiscal year.

“Person” means any individual, sole proprietorship, partnership, joint venture, trust, unincorporated organization, association, corporation, limited liability company, institution, other entity or government.

“Pledge Agreements” means the Amended and Restated Pledge Agreement dated as of the Original A&R LSA Closing Date between Therapeutics and Agent, as the same may from time to time be amended, restated, modified, assumed or otherwise supplemented, and the Pledge Agreement dated as of the Original A&R LSA Closing Date between the Company and Agent, as the same may from time to time be amended, restated, modified, assumed or otherwise supplemented.

“Prepayment Charge” shall have the meaning assigned to such term in Section 2.5.

“Qualified Cash” means the amount of Borrower’s Cash and Cash equivalents held in accounts subject to an Account Control Agreement in favor of Agent.

“Qualified Subsidiary” means any direct or indirect Domestic Subsidiary (other than Security Corporation Subsidiary) or Eligible Foreign Subsidiary.

“Receivables” means (i) all of Borrower’s Accounts, Instruments, Documents, Chattel Paper, Supporting Obligations, letters of credit, proceeds of any letter of credit, and Letter of Credit Rights, and (ii) all customer lists, software, and business records related thereto.

“Register” has the meaning specified in Section 11.7.

“Required Lenders” means at any time, the holders of more than 50% of the aggregate unpaid principal amount of the Term Loans then outstanding.

“Sanctioned Country” shall mean, at any time, a country or territory which is the subject or target of any Sanctions.

“Sanctioned Person” shall mean, at any time, (a) any Person listed in any Sanctions-related list of designated Persons maintained by the Office of Foreign Assets Control of the U.S. Department of the Treasury or the U.S. Department of State, or by the United Nations

Security Council, the European Union or any EU member state, (b) any Person operating, organized or resident in a Sanctioned Country or (c) any Person controlled by any such Person.

“Sanctions” shall mean economic or financial sanctions or trade embargoes imposed, administered or enforced from time to time by (a) the U.S. government, including those administered by the Office of Foreign Assets Control of the U.S. Department of the Treasury or the U.S. Department of State, or (b) the United Nations Security Council, the European Union or Her Majesty’s Treasury of the United Kingdom.

“SEC” means the Securities and Exchange Commission, or any successor thereto.

“Secured Obligations” means Borrower’s obligations under this Agreement and any Loan Document (other than the Warrants), including without limitation the Pledge Agreements, and including any obligation to pay any amount now owing or later arising.

“Security Corporation Investment Conditions” means that Borrower maintains Qualified Cash in an aggregate amount greater than or equal to the lesser of (i) 110% of the aggregate principal amount of Term Loan Advances outstanding under this Agreement and (ii) 100% of the Company and its consolidated Subsidiaries’ unrestricted Cash reserves, unless compliance with the foregoing conditions is waived in writing from time to time by Agent with respect to specified periods, in Agent’s sole discretion.

“Security Corporation Subsidiary” means X4 Pharmaceuticals Securities Corporation, a wholly-owned Subsidiary incorporated in the Commonwealth of Massachusetts or the State of Delaware for the purpose of holding Investments as a Massachusetts security corporation under 830 CMR 63.38B.1 of the Massachusetts tax code and applicable regulations (as the same may be amended, modified or replaced from time to time).

“Subordinated Indebtedness” means Indebtedness subordinated to the Secured Obligations in amounts and on terms and conditions satisfactory to Agent in its sole discretion and subject to a written subordination agreement in form and substance satisfactory to Agent in its sole discretion.

“Subsequent Financing” means the closing by the Company after the Closing Date of the issuance and sale of the Company’s equity securities for cash solely for financing purposes in an offering broadly marketed to multiple investors, which shall not include the issuance and sale by the Company of its equity securities (i) pursuant to benefit plans or arrangements, including under the Company’s equity incentive plans or otherwise as equity compensation, (ii) as dividends or distributions or upon stock splits, recapitalizations or similar transactions, (iii) pursuant to a merger, consolidation, acquisition, strategic alliance or similar business combination or acquisition, (iv) to banks, equipment or real property lessors or other financial institutions pursuant to a non-convertible debt financing, equipment lease, bank credit arrangement or commercial leasing transaction entered into for primarily non-equity financing purposes, (v) in connection with strategic transactions, including (A) joint ventures, manufacturing, marketing, OEM, sponsored research, collaboration or distribution arrangements or (B) technology transfer or development arrangements, (vi) securities issued or issuable to suppliers or third party service

providers in connection with the provision of goods or services, (vii) in an at-the-market (ATM) offering, (viii) securities issued to acquire any security convertible into the securities excluded from the definition of Subsequent Financing pursuant to clause (i) through (vii) above and (ix) securities issued in connection with options, warrants, convertible securities or other arrangement in existence on the Closing Date or issued in transactions excluded from the definition of Subsequent Financing pursuant to clause (i) through (viii) above; provided, however, that, if the Company or its agents attempts to “wall-cross” the Lender or its assignee or nominee in conjunction with any Subsequent Financing and the Lender or its assignee or nominee declines to be “wall-crossed,” then the issuance and sale of such equity securities shall not be considered a Subsequent Financing hereunder.

“Subsidiary” means an entity, whether corporate, partnership, limited liability company, joint venture or otherwise, in which Borrower owns or controls 50% or more of the outstanding voting securities, including each entity listed on Schedule 1 hereto.

“T6M Net Product Revenue” means Borrower’s Net Product Revenue measured on a trailing six month basis.

“Term Commitment” means as to any Lender, the obligation of such Lender, if any, to make a Term Loan Advance to the Borrower in a principal amount not to exceed the amount set forth under the heading “Term Commitment” opposite such Lender’s name on Schedule 1.1.

“Term Loan” means a loan in an aggregate principal amount of up to Thirty-Two Million Five Hundred Thousand Dollars (\$32,500,000).

“Term Loan Advance” has the meaning assigned to such term in Section 2.2(a), and any other Term Loan funds advanced under this Agreement.

“Term Loan Interest Rate” means for any day a per annum rate of interest equal to the greater of either (i) 3.15% plus the prime rate as reported in The Wall Street Journal and (ii) 10.15%.

“Term Loan Maturity Date” means April 1, 2026; provided however, if the Interest Only Extension Conditions are achieved, then July 1, 2027.

“Term Note” means a Promissory Note in substantially the form of Exhibit B.

“Trademark License” means any written agreement granting any right to use any Trademark or Trademark registration, now owned or hereafter acquired by Borrower or in which Borrower now holds or hereafter acquires any interest.

“Trademarks” means all trademarks (registered, common law or otherwise) and any applications in connection therewith, including registrations, recordings and applications in the United States Patent and Trademark Office or in any similar office or agency of the United States of America, any State thereof or any other country or any political subdivision thereof.

“UCC” means the Uniform Commercial Code as the same is, from time to time, in effect in the State of California; provided, that in the event that, by reason of mandatory provisions of law, any or all of the attachment, perfection or priority of, or remedies with respect to, Agent’s Lien on any Collateral is governed by the Uniform Commercial Code as the same is, from time to time, in effect in a jurisdiction other than the State of California, then the term “UCC” shall mean the Uniform Commercial Code as in effect, from time to time, in such other jurisdiction solely for purposes of the provisions thereof relating to such attachment, perfection, priority or remedies and for purposes of definitions related to such provisions.

“Warrants” means that certain Amended and Restated Warrant Agreement dated as of March 29, 2019 and that certain Warrant Agreement dated as of March 18, 2019, entered into by the Company in connection with the Original Agreement, as such agreements may be amended, restated or modified from time to time.

1.2 Unless otherwise specified, all references in this Agreement or any Annex or Schedule hereto to a “Section,” “subsection,” “Exhibit,” “Annex,” or “Schedule” shall refer to the corresponding Section, subsection, Exhibit, Annex, or Schedule in or to this Agreement. Unless otherwise specifically provided herein, any accounting term used in this Agreement or the other Loan Documents shall have the meaning customarily given such term in accordance with GAAP, and all financial computations hereunder shall be computed in accordance with GAAP, consistently applied. Unless otherwise defined herein or in the other Loan Documents, terms that are used herein or in the other Loan Documents and defined in the UCC shall have the meanings given to them in the UCC. For all purposes under the Loan Documents, in connection with any division or plan of division under Delaware law (or any comparable event under a different jurisdiction’s laws): (a) if any asset, right, obligation or liability of any Person becomes the asset, right, obligation or liability of a different Person, then it shall be deemed to have been transferred from the original Person to the subsequent Person and (b) if any new Person comes into existence, such new Person shall be deemed to have been organized on the first date of its existence by the holders of its Equity Interests at such time.

SECTION 2. THE LOAN

2.1 [Intentionally omitted.]

2.2 Term Loan.

(a) Term Loan Advances. Pursuant to the Original A&R LSA, the Lenders party thereto extended "Term Loans" (under and as defined in the A&R LSA) (the "Original A&R LSA Term Loans") to Borrower in the original aggregate principal amount of Thirty-Two Million Five Hundred Thousand Dollars (\$32,500,000). Borrower acknowledges and agrees that, as of the Closing Date, Thirty-Two Million Five Hundred Thousand Dollars (\$32,500,000) (the “Conversion Balance”) of the principal amount of the Original A&R LSA Term Loans remains outstanding and such entire outstanding principal balance shall for all purposes hereunder be deemed to constitute and be referred

to, and hereby is converted into, a Term Loan Advance in like amount hereunder, without constituting a novation, and shall be deemed an Advance on the Closing Date for purposes of this Agreement. Subject to the terms and conditions of this Agreement, the Lenders will severally (and not jointly) make in an amount not to exceed their respective Term Commitments, and Borrower agrees to draw, such Term Loan Advance of \$32,500,000 (the "Term Loan Advance"), inclusive of the Conversion Balance on the Closing Date.

(b) **Advance Request.** To obtain a Term Loan Advance, Borrower shall complete, sign and deliver an Advance Request (at least one (1) Business Day before the Closing Date and at least five (5) Business Days before each Advance Date other than the Closing Date) to Agent. The Lenders shall fund the Term Loan Advance in the manner requested by the Advance Request provided that each of the conditions precedent to such Term Loan Advance is satisfied as of the requested Advance Date.

(c) **Term Loan Interest Rate.** The principal balance of each Term Loan Advance shall bear interest thereon from such Advance Date at the Term Loan Interest Rate based on a year consisting of 360 days, with interest computed daily based on the actual number of days elapsed. The Term Loan Interest Rate will float and change on the day the prime rate changes from time to time. Notwithstanding anything to the contrary in this Agreement, the outstanding principal balance of the Original A&R LSA Term Loans shall have accrued interest at the "Term Loan Interest Rate" (as defined in the Original A&R LSA) through the date immediately preceding the Closing Date, and any such accrued but unpaid interest shall be due and payable on the next scheduled interest payment date following the Closing Date pursuant to Section 2.2(d).

(d) **Payment.** Borrower will pay interest on each Term Loan Advance on the first Business Day of each month, beginning the month after the corresponding Advance Date. Borrower shall repay the aggregate Term Loan principal balance that is outstanding on the day immediately preceding the Amortization Date, in equal monthly installments of principal and interest (mortgage style) beginning on the Amortization Date and continuing on the first Business Day of each month thereafter until the Secured Obligations (other than inchoate indemnity obligations and other obligations that are stated to survive termination of this Agreement) are repaid. The entire Term Loan principal balance and all accrued but unpaid interest hereunder, shall be due and payable on the Term Loan Maturity Date. Borrower shall make all payments under this Agreement without setoff, recoupment or deduction and regardless of any counterclaim or defense. If a payment hereunder becomes due and payable on a day that is not a Business Day, the due date thereof shall be the immediately preceding Business Day. The Lenders will initiate debit entries to the Borrower's account as authorized on the ACH Authorization (i) on each payment date of all periodic obligations payable to the Lenders under each Term Advance and (ii) reasonable and documented out-of-pocket legal fees and costs incurred by Agent or the Lenders in connection with Section 11.11 of this Agreement; provided that, with respect to clause (i) above, in the event that the Lenders or Agent informs Borrower that the Lenders will not initiate a debit entry to Borrower's account for a certain amount of the periodic obligations due on a specific

payment date, Borrower shall pay to the Lenders such amount of periodic obligations in full in immediately available funds on such payment date; provided, further, that, with respect to clause (i) above, if the Lenders or Agent informs Borrower that the Lenders will not initiate a debit entry as described above later than the date that is three (3) Business Days prior to such payment date, Borrower shall pay to the Lenders such amount of periodic obligations in full in immediately available funds on the date that is three (3) Business Days after the date on which the Lenders or Agent notifies Borrower of such; provided, further, that, with respect to clause (ii) above, in the event that the Lenders or Agent informs Borrower that the Lenders will not initiate a debit entry to Borrower's account for certain amount of such out-of-pocket legal fees and costs incurred by Agent or the Lenders, Borrower shall pay to the Lenders such amount in full in immediately available funds within three (3) Business Days.

2.3 Maximum Interest. Notwithstanding any provision in this Agreement or any other Loan Document, it is the parties' intent not to contract for, charge or receive interest at a rate that is greater than the maximum rate permissible by law that a court of competent jurisdiction shall deem applicable hereto (which under the laws of the State of California shall be deemed to be the laws relating to permissible rates of interest on commercial loans) (the "Maximum Rate"). If a court of competent jurisdiction shall finally determine that Borrower has actually paid to the Lenders an amount of interest in excess of the amount that would have been payable if all of the Secured Obligations had at all times borne interest at the Maximum Rate, then such excess interest actually paid by Borrower shall be applied as follows: first, to the payment of the Secured Obligations consisting of the outstanding principal; second, after all principal is repaid, to the payment of the Lenders' accrued interest, costs, expenses, professional fees and any other Secured Obligations permitted under this Agreement; and third, after all Secured Obligations are repaid, the excess (if any) shall be refunded to Borrower.

2.4 Default Interest. In the event any payment is not paid on the scheduled payment date, an amount equal to four percent (4%) of the past due amount shall be payable on demand. In addition, upon the occurrence and during the continuation of an Event of Default hereunder, all unpaid Secured Obligations, including principal, interest, compounded interest, and professional fees, shall bear interest at a rate per annum equal to the rate set forth in 2.2(c), plus four percent (4%) per annum. In the event any interest is not paid when due hereunder, delinquent interest shall be added to principal and shall bear interest on interest, compounded at the rate set forth in Section 2.2(c) or Section 2.4, as applicable.

2.5 Prepayment. At its option upon at least seven (7) Business Days prior written notice to Agent (or such shorter notice period as agreed by Agent in its discretion), Borrower may prepay all, but not less than all, of the outstanding Advances by paying the entire principal balance, all accrued and unpaid interest thereon, together with a prepayment charge equal to the following percentage of the Advance amount being prepaid: if such prepayment is made (a) during any of the first twelve (12) months following the Closing Date, 3.0%; (b) after twelve (12) months but prior to twenty four (24) months following the Closing Date, 2.0%; and (c) after twenty four (24) months

following the Closing Date, but prior to the Term Loan Maturity Date, 1.0% (each, a “Prepayment Charge”). Borrower agrees that the Prepayment Charge is a reasonable calculation of Lenders’ lost profits in view of the difficulties and impracticality of determining actual damages resulting from an early repayment of the Advances. Borrower shall prepay the outstanding amount of all principal and accrued interest through the prepayment date and the Prepayment Charge upon the occurrence of a Change in Control or any other prepayment hereunder. Notwithstanding the foregoing, Agent and Lenders agree to waive the Prepayment Charge if Agent and Lenders (in their sole and absolute discretion) agree in writing to refinance the Advances prior to the Term Loan Maturity Date.

2.6 End of Term Charges.

(a) On the Closing Date, Borrower shall pay Lender a charge in an amount equal to \$1,300,000 in connection with the Original A&R LSA Term Loans (“End of Term Charge I”). Notwithstanding the required payment date of the End of Term Charge I, the applicable pro rata portion of the End of Term Charge I shall be deemed earned by each Lender as of each date the applicable Original A&R LSA Term Loan Advances were made.

(b) On the earliest to occur of (i) July 1, 2023, (ii) the date that Borrower prepays the outstanding Secured Obligations (other than any inchoate indemnity obligations and any other obligations which, by their terms, are to survive the termination of this Agreement) in full and (iii) the date that the Secured Obligations become due and payable, Borrower shall pay Lender a charge in an amount equal to \$763,750 (“End of Term Charge II”) in connection with certain of the Original A&R LSA Term Loans. Notwithstanding the required payment date of the End of Term Charge II, the applicable pro rata portion of the End of Term Charge II shall be deemed earned by each Lender as of each date a Term Loan Advance was made.

(c) On the earliest to occur of (i) the Term Loan Maturity Date, (ii) the date that Borrower prepays the outstanding Secured Obligations (other than any inchoate indemnity obligations and any other obligations which, by their terms, are to survive the termination of this Agreement) in full and (iii) the date that the Secured Obligations become due and payable, Borrower shall pay Lender a charge in the amount equal to \$1,300,000 (“End of Term Charge III” and together with “End of Term Charge I” and “End of Term Charge II”, collectively, the “End of Term Charge”). Notwithstanding the required payment date of the End of Term Charge III, the applicable pro rata portion of the End of Term Charge III shall be deemed earned by each Lender as of each date a Term Loan Advance is made.

2.7 Notes. If so requested by each Lender by written notice to Borrower, then Borrower shall execute and deliver to Lender (and/or, if applicable and if so specified in such notice, to any Person who is an assignee of Lender pursuant to Section 11.13) (promptly after the Borrower’s receipt of such notice) a Note or Notes to evidence Lender’s Loans.

2.8 Pro Rata Treatment. Each payment (including prepayment) on account of any fee and any reduction of the Term Loans shall be made pro rata according to the Term Commitments of the relevant Lender.

2.9 Treatment of Prepayment Charge and End of Term Charge. Borrower agrees that any Prepayment Charge and any End of Term Charge payable shall be presumed to be the liquidated damages sustained by each Lender as the result of the early termination, and Borrower agrees that it is reasonable under the circumstances currently existing and existing as of the Closing Date. The Prepayment Charge and the End of Term Charge shall also be payable in the event the Secured Obligations (and/or this Agreement) are satisfied or released by foreclosure (whether by power of judicial proceeding), deed in lieu of foreclosure, or by any other means. Borrower expressly waives (to the fullest extent it may lawfully do so) the provisions of any present or future statute or law that prohibits or may prohibit the collection of the foregoing Prepayment Charge and End of Term Charge in connection with any such acceleration. Borrower agrees (to the fullest extent that each may lawfully do so): (a) each of the Prepayment Charge and the End of Term Charge is reasonable and is the product of an arm's length transaction between sophisticated business people, ably represented by counsel; (b) each of the Prepayment Charge and the End of Term Charge shall be payable notwithstanding the then prevailing market rates at the time payment is made; (c) there has been a course of conduct between the Lenders and Borrower giving specific consideration in this transaction for such agreement to pay the Prepayment Charge and the End of Term Charge as a charge (and not interest) in the event of prepayment or acceleration; and (d) Borrower shall be estopped from claiming differently than as agreed to in this paragraph. Borrower expressly acknowledges that their agreement to pay each of the Prepayment Charge and the End of Term Charge to the Lenders as herein described was on the Closing Date and continues to be a material inducement to the Lenders to provide the Term Loans.

2.10 Taxes; Increased Costs. The Borrower, the Agent and the Lenders each hereby agree to the terms and conditions set forth on Addendum 1 attached hereto.

SECTION 3. SECURITY INTEREST

3.1 As security for the prompt and complete payment when due (whether on the payment dates or otherwise) of all the Secured Obligations, Borrower grants to Agent a security interest in all of Borrower's right, title, and interest in, to and under all of Borrower's personal property and other assets including without limitation the following (except as set forth herein) whether now owned or hereafter acquired (collectively, the "Collateral"): (a) Receivables; (b) Equipment; (c) Fixtures; (d) General Intangibles (other than Intellectual Property); (e) Inventory; (f) Investment Property; (g) Deposit Accounts; (h) Cash; (i) Goods; and all other tangible and intangible personal property of Borrower whether now or hereafter owned or existing, leased, consigned by or to, or acquired by, Borrower and wherever located, and any of Borrower's property in the possession or under the control of Agent; and, to the extent not otherwise included, all Proceeds of each of the foregoing and all accessions to, substitutions and replacements for, and rents, profits and products of each of the foregoing; provided, however, that the Collateral shall include all

Accounts and General Intangibles that consist of rights to payment and proceeds from the sale, licensing or disposition of all or any part, or rights in, the Intellectual Property (the "Rights to Payment"). Notwithstanding the foregoing, if a judicial authority (including a U.S. Bankruptcy Court) holds that a security interest in the underlying Intellectual Property is necessary to have a security interest in the Rights to Payment, then the Collateral shall automatically, and effective as of the date of this Agreement, include the Intellectual Property to the extent necessary to permit perfection of Agent's security interest in the Rights to Payment.

3.2 Notwithstanding the broad grant of the security interest set forth in Section 3.1, above, the Collateral shall not include (a) more than 65% of the presently existing and hereafter arising issued and outstanding shares of capital stock owned by Borrower of any Foreign Subsidiary (other than an Eligible Foreign Subsidiary) which shares entitle the holder thereof to vote for directors or any other matter, (b) any Intellectual Property except to the extent described in Section 3.1 above, (c) nonassignable licenses or contracts, which by their terms require the consent of the licensor thereof or another party (but only to the extent such prohibition on transfer is enforceable under applicable law, including, without limitation, Sections 9406, 9407 and 9408 of the UCC), and (d) any leasehold real property interest, license, lease or other contract or agreement or any property subject to a purchase money security interest or similar arrangement to the extent that a grant of a security interest therein would violate or invalidate such lease, license, contract or agreement or purchase money arrangement or create a right of termination in favor of any other party thereto (but only to the extent such prohibition on transfer or grant of a security interest is enforceable under applicable law, including, without limitation, Sections 9406, 9407 and 9408 of the UCC), (e) any property to the extent that, and for as long as, such grant of a security interest is prohibited by any applicable law, rule or regulation; provided that the foregoing exclusion in this clause (e) shall in no way be construed (i) to apply to the extent that any described prohibition is unenforceable under Section 9406, 9407 or 9408 of the UCC or other applicable law or (ii) to apply to the extent that any consent or waiver has been obtained, or is hereafter obtained, that would permit the Agent's security interest or Lien notwithstanding the prohibition on the grant of a security interest in such property (f) Excluded Accounts, (g) motor vehicles or other assets in which a security interest may be perfected only through compliance with a certificate of title statute, (h) any property subject to the Sanofi Agreement as disclosed on Schedule 3.2 hereto, and (i) any Cash securing reimbursement obligations permitted under this Agreement.

SECTION 4. CONDITIONS PRECEDENT TO LOAN

The obligations of the Lenders to make the Loan hereunder are subject to the satisfaction by Borrower of the following conditions:

4.1 Initial Advance. On or prior to the Closing Date, Borrower shall have delivered to Agent the following:

(a) executed copies of the Loan Documents, Account Control Agreements, a legal opinion of Borrower's counsel, and all other documents and instruments reasonably

required by Agent to effectuate the transactions contemplated hereby or to create and perfect the Liens of Agent with respect to all Collateral, in all cases in form and substance reasonably acceptable to Agent;

(b) certified copy of resolutions of Borrower's board of directors evidencing approval of the Loan and other transactions evidenced by the Loan Documents;

(c) certified copies of the Certificate of Incorporation and the Bylaws, as amended through the Closing Date, of Borrower;

(d) a certificate of good standing for Borrower from its state of incorporation and similar certificates from all other jurisdictions in which it does business and where the failure to be qualified could have a Material Adverse Effect;

(e) payment of the Facility Charge, the End of Term Charge I and reimbursement of Agent's and the Lenders' reasonable and documented expenses reimbursable pursuant to this Agreement, which amounts may be deducted from the initial Advance;

(f) all certificates of insurance and to the extent requested by Agent, copies of each insurance policy required hereunder; and

(g) such other documents as Agent may reasonably request.

4.2 All Advances. On each Advance Date:

(a) Agent shall have received (i) an Advance Request for the relevant Advance as required by Section 2.2(b), each duly executed by Borrower's Chief Executive Officer or Chief Financial Officer, (ii) payment of the applicable Facility Charge then due, and (iii) any other documents Agent may reasonably request.

(b) The representations and warranties set forth in this Agreement shall be true and correct in all material respects on and as of the Advance Date with the same effect as though made on and as of such date, except to the extent such representations and warranties expressly relate to an earlier date, and representations and warranties that may be updated pursuant to this Agreement shall be true and correct in all material respects as of the date made, provided that such updated representations and warranties shall not apply to an earlier date and shall not cure any default arising from any false or incorrect representations and warranties previously made.

(c) Borrower shall be in compliance with all the terms and provisions set forth herein and in each other Loan Document on its part to be observed or performed, and at the time of and immediately after such Advance no Event of Default shall have occurred and be continuing.

(d) Each Advance Request shall be deemed to constitute a representation and warranty by Borrower on the relevant Advance Date as to the matters specified in

paragraphs (b) and (c) of this Section 4.2 and as to the matters set forth in the Advance Request.

4.3 No Default. As of the Closing Date and each Advance Date, (i) no fact or condition exists that could reasonably (or could reasonably, with the passage of time, the giving of notice, or both) constitute an Event of Default and (ii) no event that has had or could reasonably be expected to have a Material Adverse Effect has occurred and is continuing.

SECTION 5. REPRESENTATIONS AND WARRANTIES OF BORROWER

Borrower represents and warrants that:

5.1 Corporate Status. Borrower is a corporation duly organized, legally existing and in good standing under the laws of the State of Delaware, and is duly qualified as a foreign corporation in all jurisdictions in which the nature of its business or location of its properties require such qualifications and where the failure to be qualified could reasonably be expected to have a Material Adverse Effect. Borrower's present name, former names (if any), locations, place of formation, tax identification number, organizational identification number and other information are correctly set forth in Exhibit C, as may be updated by Borrower in a written notice (including any Compliance Certificate) provided to Agent after the Closing Date.

5.2 Collateral. Borrower owns the Collateral and the Intellectual Property, free of all Liens, except for Permitted Liens. Borrower has the power and authority to grant to Agent a Lien in the Collateral as security for the Secured Obligations.

5.3 Consents. Borrower's execution, delivery and performance of this Agreement and all other Loan Documents (i) have been duly authorized by all necessary corporate action of Borrower, (ii) will not result in the creation or imposition of any Lien upon the Collateral, other than Permitted Liens and the Liens created by this Agreement and the other Loan Documents, (iii) do not violate any provisions of Borrower's Certificate or Articles of Incorporation (as applicable), bylaws, or any material law, regulation, order, injunction, judgment, decree or writ to which Borrower is subject and (iv) except as described on Schedule 5.3, do not violate any material contract or agreement or require the consent or approval of any other Person which has not already been obtained. The individual or individuals executing the Loan Documents are duly authorized to do so.

5.4 Material Adverse Effect. No event that has had or could reasonably be expected to have a Material Adverse Effect has occurred and is continuing. Borrower is not aware of any event likely to occur that is reasonably expected to result in a Material Adverse Effect.

5.5 Actions Before Governmental Authorities. There are no actions, suits or proceedings at law or in equity or by or before any governmental authority now pending or, to the knowledge of Borrower, threatened in writing against Borrower or its property, that is reasonably expected to result in a Material Adverse Effect.

5.6 Laws. Neither Borrower nor any of its Subsidiaries is in violation of any law, rule or regulation, or in default with respect to any judgment, writ, injunction or decree of any governmental authority, where such violation or default is reasonably expected to result in a Material Adverse Effect. Borrower is not in default in any manner under any provision of any agreement or instrument evidencing material Indebtedness, or any other material agreement to which it is a party or by which it is bound.

Neither Borrower nor any of its Subsidiaries is an “investment company” or a company “controlled” by an “investment company” under the Investment Company Act of 1940, as amended. Neither Borrower nor any of its Subsidiaries is engaged as one of its important activities in extending credit for margin stock (under Regulations X, T and U of the Federal Reserve Board of Governors). Borrower and each of its Subsidiaries has complied in all material respects with the Federal Fair Labor Standards Act. Neither Borrower nor any of its Subsidiaries is a “holding company” or an “affiliate” of a “holding company” or a “subsidiary company” of a “holding company” as each term is defined and used in the Public Utility Holding Company Act of 2005. Neither Borrower’s nor any of its Subsidiaries’ properties or assets has been used by Borrower or such Subsidiary or, to Borrower’s knowledge, by previous Persons, in disposing, producing, storing, treating, or transporting any hazardous substance other than in material compliance with applicable laws. Borrower and each of its Subsidiaries has obtained all consents, approvals and authorizations of, made all declarations or filings with, and given all notices to, all Governmental Authorities that are necessary to continue their respective businesses as currently conducted.

None of Borrower, any of its Subsidiaries, or any of Borrower’s or its Subsidiaries’ Affiliates or any of their respective agents acting or benefiting in any capacity in connection with the transactions contemplated by this Agreement is (i) in violation of any Anti-Terrorism Law, (ii) engaging in or conspiring to engage in any transaction that evades or avoids, or has the purpose of evading or avoiding or attempts to violate, any of the prohibitions set forth in any Anti-Terrorism Law, or (iii) is a Blocked Person. None of Borrower, any of its Subsidiaries, or to the knowledge of Borrower and any of their Affiliates or agents, acting or benefiting in any capacity in connection with the transactions contemplated by this Agreement, (x) conducts any business or engages in making or receiving any contribution of funds, goods or services to or for the benefit of any Blocked Person, or (y) deals in, or otherwise engages in any transaction relating to, any property or interest in property blocked pursuant to Executive Order No. 13224, any similar executive order or other Anti-Terrorism Law. None of the funds to be provided under this Agreement will be used, directly or indirectly, (a) for any activities in violation of any applicable anti-money laundering, economic sanctions and anti-bribery laws and regulations laws and regulations or (b) for any payment to any governmental official or employee, political party, official of a political party, candidate for political office, or

anyone else acting in an official capacity, in order to obtain, retain or direct business or obtain any improper advantage, in violation of the United States Foreign Corrupt Practices Act of 1977, as amended.

5.7 Information Correct and Current. No written information, report, Advance Request, financial statement, exhibit or schedule furnished, by or on behalf of Borrower to Agent in connection with any Loan Document or included therein or delivered pursuant thereto contained, or, when taken as a whole, contains or will contain any material misstatement of fact or, when taken together with all other such information or documents, omitted, omits or will omit to state any material fact necessary to make the statements therein, in the light of the circumstances under which they were, are or will be made, not materially misleading at the time such statement was made or deemed made. Additionally, any and all financial or business projections provided by Borrower to Agent, whether prior to or after the Closing Date, shall be (i) provided in good faith and based on the most current data and information available to Borrower, and (ii) the most current of such projections provided to Borrower's Board of Directors (it being understood that such projections are subject to significant uncertainties and contingencies, many of which are beyond the control of Borrower, that no assurance is given that any particular projections will be realized, and that actual results may differ).

5.8 Tax Matters. Except as described on Schedule 5.8 and except those being contested in good faith with adequate reserves under GAAP, (a) Borrower has filed all material federal, state and local tax returns that it is required to file, (b) Borrower has duly paid or fully reserved for all taxes or installments thereof (including any interest or penalties) as and when due, which have become due pursuant to such returns, and (c) Borrower has paid or fully reserved for any tax assessment received by Borrower for the three (3) years preceding the Closing Date, if any (including any taxes being contested in good faith and by appropriate proceedings), in each case, other than with respect to taxes that do not exceed, individually or in the aggregate, \$50,000.

5.9 Intellectual Property Claims. Borrower is the sole owner of, or otherwise has the right to use, the Intellectual Property material to Borrower's business. Except as described on Schedule 5.9, (i) to the best knowledge of Borrower, each of the material Copyrights, Trademarks and Patents is valid and enforceable, (ii) no material part of the Intellectual Property has been judged invalid or unenforceable, in whole or in part, and (iii) no claim has been made to Borrower that any material part of the Intellectual Property violates the rights of any third party. Exhibit D is a true, correct and complete list of each of Borrower's Patents, registered Trademarks, registered Copyrights, and material agreements under which Borrower licenses Intellectual Property from third parties (other than shrink-wrap software licenses), together with application or registration numbers, as applicable, owned by Borrower or any Subsidiary, in each case as of the Closing Date. Borrower is not in material breach of, nor has Borrower failed to perform any material obligations under, any of the foregoing contracts, licenses or agreements and, to Borrower's knowledge, no third party to any such contract, license or agreement is in material breach thereof or has failed to perform any material obligations thereunder.

5.10 Intellectual Property. Except as described on Schedule 5.10, to the best knowledge of Borrower, Borrower has all material rights with respect to Intellectual Property that it uses in, and that is necessary or material in the operation or conduct of Borrower's business as currently conducted and proposed to be conducted by Borrower. Without limiting the generality of the foregoing, and in the case of Licenses, except for restrictions that are unenforceable under Division 9 of the UCC, Borrower has the right, to the extent required to operate Borrower's business, to freely transfer, license or assign Intellectual Property necessary or material in the operation or conduct of Borrower's business as currently conducted by Borrower, without condition, restriction or payment of any kind (other than license payments in the ordinary course of business) to any third party, and Borrower owns or has the right to use, pursuant to valid licenses, all software development tools, library functions, compilers and all other third-party software and other items that are material to Borrower's business and used in the design, development, promotion, sale, license, manufacture, import, export, use or distribution of Borrower Products that are material to Borrower's business except customary covenants in inbound license agreements and equipment leases where Borrower is the licensee or lessee.

5.11 Borrower Products. Except as described on Schedule 5.11, which may be updated by Borrower in a written notice provided after the Closing Date, no Intellectual Property owned by Borrower or Borrower Product has been or is subject to any actual or, to the knowledge of Borrower, threatened in writing litigation, proceeding (including any proceeding in the United States Patent and Trademark Office or any corresponding foreign office or agency) or outstanding decree, order, judgment, settlement agreement or stipulation that restricts in any manner Borrower's use, transfer or licensing thereof or that may affect the validity, use or enforceability thereof, in such case, which could reasonably be expected to have a Material Adverse Effect. There is no decree, order, judgment, agreement, stipulation, arbitral award or other provision entered into in connection with any litigation or proceeding that obligates Borrower to grant licenses or ownership interest in any future material Intellectual Property related to the operation or conduct of the business of Borrower or Borrower Products. Except as set forth on Schedule 5.11, Borrower has not received any written notice or claim, challenging or questioning Borrower's ownership in any Intellectual Property material to Borrower's business (or written notice of any claim challenging or questioning the ownership in any material licensed Intellectual Property of the owner thereof) or suggesting that any third party has any claim of legal or beneficial ownership with respect thereto nor, to Borrower's knowledge, is there a reasonable basis for any such claim. Neither Borrower's use of its Intellectual Property material to Borrower's business nor the production and sale of Borrower Products material to Borrower's business infringes in any material respect the Intellectual Property or other rights of others.

5.12 Financial Accounts. Exhibit E, as may be updated by the Borrower in a written notice provided to Agent after the Closing Date, is a true, correct and complete list of (a) all banks and other financial institutions at which Borrower or any Subsidiary maintains Deposit Accounts and (b) all institutions at which Borrower or any Subsidiary maintains an account holding Investment Property, and such exhibit correctly identifies the name, address and telephone number of each bank or other institution, the name in

which the account is held, a description of the purpose of the account, and the complete account number therefor.

5.13 Employee Loans. Except as described on Schedule 5.13, which may be updated by Borrower in a written notice provided after the Closing Date, Borrower has no outstanding loans to any employee, officer or director of the Borrower nor has Borrower guaranteed the payment of any loan made to an employee, officer or director of the Borrower by a third party.

5.14 Capitalization and Subsidiaries. Borrower's capitalization as of the Closing Date is set forth on Schedule 5.14 annexed hereto. Borrower does not own any stock, partnership interest or other securities of any Person, except for Permitted Investments. Attached as Schedule 5.14, as may be updated by Borrower in a written notice provided after the Closing Date, is a true, correct and complete list of each Subsidiary.

5.15 Foreign Subsidiary Voting Rights. No decision or action in any governing document of any Foreign Subsidiary (other than an Eligible Foreign Subsidiary) requires a vote of greater than 50.1% of the Equity Interests or voting rights of such Foreign Subsidiary.

SECTION 6. INSURANCE; INDEMNIFICATION

6.1 Coverage. Borrower shall cause to be carried and maintained commercial general liability insurance, on an occurrence form, against risks customarily insured against in Borrower's line of business. Such risks shall include the risks of bodily injury, including death, property damage, personal injury, advertising injury, and contractual liability per the terms of the indemnification agreement found in Section 6.3. Borrower must maintain a minimum of \$2,000,000 of commercial general liability insurance for each occurrence. Borrower has and agrees to maintain a minimum of \$2,000,000 of directors' and officers' insurance for each occurrence and \$5,000,000 in the aggregate. So long as there are any Secured Obligations outstanding (other than inchoate indemnity obligations and other obligations which are expressly stated to survive termination of this Agreement), Borrower shall also cause to be carried and maintained insurance upon the Collateral, insuring against all risks of physical loss or damage howsoever caused, in an amount not less than the full replacement cost of the Collateral, provided that such insurance may be subject to standard exceptions and deductibles. If Borrower fails to obtain the insurance called for by this Section 6.1 or fails to pay any premium thereon or fails to pay any other amount which Borrower is obligated to pay under this Agreement or any other Loan Document or which may be required to preserve the Collateral, Agent may obtain such insurance or make such payment, and all amounts so paid by Agent are immediately due and payable, bearing interest at the then highest rate applicable to the Secured Obligations, and secured by the Collateral. Agent will make reasonable efforts to provide Borrower with notice of Agent obtaining such insurance at the time it is obtained or within a reasonable time thereafter. No payments by Agent are deemed an agreement to make similar payments in the future or Agent's waiver of any Event of Default.

6.2 Certificates. Borrower shall deliver to Agent certificates of insurance that evidence Borrower's compliance with its insurance obligations in Section 6.1 and the obligations contained in this Section 6.2. Borrower's insurance certificate shall state Agent (shown as "Hercules Capital, Inc.", as Agent") is an additional insured for commercial general liability, a loss payee for all risk property damage insurance, subject to the insurer's approval, and a loss payee for property insurance and additional insured for liability insurance for any future insurance that Borrower may acquire from such insurer. Attached to the certificates of insurance will be additional insured endorsements for liability and lender's loss payable endorsements for all risk property damage insurance. All certificates of insurance will provide for a minimum of thirty (30) days advance written notice to Agent of cancellation (other than cancellation for non-payment of premiums, for which ten (10) days' advance written notice shall be sufficient) or any other change adverse to Agent's interests. Any failure of Agent to scrutinize such insurance certificates for compliance is not a waiver of any of Agent's rights, all of which are reserved. Borrower shall provide Agent with copies of each insurance policy within thirty (30) days of the Closing Date, and upon entering or amending any insurance policy required hereunder, Borrower shall provide Agent with copies of such policies and shall promptly deliver to Agent updated insurance certificates with respect to such policies.

6.3 Indemnity. Borrower agrees to indemnify and hold Agent, the Lenders and their officers, directors, employees, agents, in-house attorneys, representatives and shareholders (each, an "Indemnified Person") harmless from and against any and all claims, costs, expenses, damages and liabilities (including such claims, costs, expenses, damages and liabilities based on liability in tort, including strict liability in tort), including reasonable attorneys' fees and disbursements and other costs of investigation or defense (including those incurred upon any appeal) (collectively, "Liabilities"), that may be instituted or asserted against or incurred by such Indemnified Person as the result of credit having been extended, suspended or terminated under this Agreement and the other Loan Documents or the administration of such credit, or in connection with or arising out of the transactions contemplated hereunder and thereunder, or any actions or failures to act in connection therewith, or arising out of the disposition or utilization of the Collateral, excluding in all cases Liabilities to the extent resulting solely from any Indemnified Person's gross negligence or willful misconduct. Borrower agrees to pay, and to save Agent and Lender harmless from, any and all liabilities with respect to, or resulting from any delay in paying, any and all excise, sales or other similar taxes (excluding taxes imposed on or measured by the net income of Agent or Lender) that may be payable or determined to be payable with respect to any of the Collateral or this Agreement, excluding in all cases Liabilities to the extent resulting directly from any Indemnified Person's gross negligence or willful misconduct. In no event shall any Indemnified Person be liable on any theory of liability for any special, indirect, consequential or punitive damages (including any loss of profits, business or anticipated savings). This Section 6.3 shall not apply with respect to taxes other than any taxes that represent losses, claims, damages, etc. arising from any non-tax claim. This Section 6.3 shall survive the repayment of indebtedness under, and otherwise shall survive the expiration or other termination of, the Agreement.

SECTION 7. COVENANTS OF BORROWER

Borrower agrees as follows:

7.1 Financial Reports. Borrower shall furnish to Agent the financial statements and reports listed hereinafter (the "Financial Statements"):

(a) as soon as practicable (and in any event within 30 days) after the end of each month, unaudited interim and year-to-date financial statements as of the end of such month (prepared on a consolidated and consolidating basis, if applicable), including balance sheet and related statements of income and cash flows accompanied by a report detailing any material contingencies (including the commencement of any material litigation by or against Borrower) or any other occurrence that could reasonably be expected to have a Material Adverse Effect, all certified by Borrower's Chief Executive Officer or Chief Financial Officer to the effect that they have been prepared in accordance with GAAP, except (i) for the absence of footnotes, (ii) that they are subject to normal year-end adjustments, and (iii) they do not contain certain non-cash items that are customarily included in quarterly and annual financial statements;

(b) as soon as practicable (and in any event within 45 days) after the end of each of the first three calendar quarters of each year, unaudited interim and year-to-date financial statements as of the end of such calendar quarter (prepared on a consolidated and consolidating basis, if applicable), including balance sheet and related statements of income and cash flows accompanied by a report detailing any material contingencies (including the commencement of any material litigation by or against Borrower) or any other occurrence that could reasonably be expected to have a Material Adverse Effect, certified by Borrower's Chief Executive Officer or Chief Financial Officer to the effect that they have been prepared in accordance with GAAP, except (i) for the absence of footnotes, and (ii) that they are subject to normal year-end adjustments;

(c) as soon as practicable (and in any event within ninety (90) days) after the end of each fiscal year, unqualified audited financial statements as of the end of such year (prepared on a consolidated and consolidating basis, if applicable), including balance sheet and related statements of income and cash flows, and setting forth in comparative form the corresponding figures for the preceding fiscal year, certified by a firm of independent certified public accountants selected by Borrower and reasonably acceptable to Agent, accompanied by any management report from such accountants (Agent hereby acknowledges that PwC is an acceptable firm of independent public accountants);

(d) as soon as practicable (and in any event within 30 days) after the end of each month, a Compliance Certificate in the form of Exhibit F;

(e) as soon as practicable (and in any event within 30 days) after the end of each month, a report showing agings of accounts receivable and accounts payable;

(f) promptly and in any event within 5 days after the sending or filing thereof, as the case may be, copies of any proxy statements, financial statements or reports that Borrower has made generally available to holders of its Common Stock and copies of any regular, periodic and special reports or registration statements that Borrower files with the Securities and Exchange Commission or any governmental authority that may be substituted therefor, or any national securities exchange;

(g) at the same time and in the same manner as it gives to its Board of Directors, copies of all board packages that Borrower provides to its directors in connection with meetings of the Board of Directors, and within 30 days after each such meeting, minutes of such meeting, provided that in all cases Borrower may exclude confidential compensation information, information presenting a conflict of interest with Agent or Lender and information covered by attorney-client privilege;

(h) any budget and any forecast of Borrower promptly following its approval by Borrower's Board of Directors, and in any event, not less than once annually, no later than 60 days following the end of the fiscal year;

(i) such other financial information reasonably requested by Agent; and

(j) immediate notice if Borrower or any Subsidiary has knowledge that Borrower, or any Subsidiary or Affiliate of Borrower, is listed on the OFAC Lists or (a) is convicted on, (b) pleads *nolo contendere* to, (c) is indicted on, or (d) is arraigned and held over on charges involving money laundering or predicate crimes to money laundering.

Borrower shall not (without the consent of Agent, such consent not to be unreasonably withheld or delayed), make any change in its (a) accounting policies or reporting practices, except as required by GAAP or (b) fiscal years or fiscal quarters. As of the Closing Date, the fiscal year of Borrower ends on December 31.

The executed Compliance Certificate and all Financial Statements required to be delivered pursuant to clauses (a), (b) and (c) shall be sent via e-mail to _____ with a copy to _____, _____, and _____ and _____ provided, that if e-mail is not available or sending such Financial Statements via e-mail is not possible, they shall be faxed to Agent at: _____, attention Account Manager: X4 Pharmaceuticals, Inc.

Notwithstanding the foregoing, documents required to be delivered pursuant to the terms hereof (to the extent any such documents are included in materials otherwise filed with the SEC) may be delivered electronically and if so delivered, shall be deemed to have been delivered on the date on which Borrower emails a link thereto to Agent.

7.2 Management Rights. Borrower shall permit any representative that Agent or the Lenders authorize, including its attorneys and accountants, to inspect the Collateral and examine and make copies and abstracts of the books of account and records of Borrower at reasonable times and upon reasonable notice during normal business hours; provided, however, that so long as no Event of Default has occurred and is continuing,

such examinations shall be limited to no more often than twice per fiscal year. In addition, any such representative shall have the right to meet with management and officers of Borrower to discuss such books of account and records at reasonable times and upon reasonable notice during normal business hours. In addition, Agent or Lender shall be entitled at reasonable times and intervals to consult with and advise the management and officers of Borrower concerning significant business issues affecting Borrower; provided that management and officers of Borrower shall not be bound to accept such advisement. Such consultations shall not unreasonably interfere with Borrower's business operations. The parties intend that the rights granted Agent and the Lenders shall constitute "management rights" within the meaning of 29 C.F.R. Section 2510.3-101(d)(3)(ii), but that any advice, recommendations or participation by Agent or the Lenders with respect to any business issues shall not be deemed to give Agent or the Lenders, nor be deemed an exercise by Agent or the Lenders of, control over Borrower's management or policies.

7.3 Further Assurances. Borrower shall from time to time following Agent's request execute, deliver and file, alone or with Agent, any financing statements, security agreements, collateral assignments, notices, control agreements, or other documents to perfect or give the highest priority to Agent's Lien on the Collateral or otherwise evidence Agent's rights herein. Borrower shall from time to time procure any instruments or documents as may be reasonably requested by Agent, and take all further action that may be necessary, or that Agent may reasonably request, to perfect and protect the Liens granted hereby and thereby. In addition, and for such purposes only, Borrower hereby authorizes Agent to execute and deliver on behalf of Borrower and to file such financing statements (including an indication that the financing statement covers "all assets or all personal property" of Borrower in accordance with Section 9-504 of the UCC), collateral assignments, notices, control agreements, security agreements and other documents without the signature of Borrower either in Agent's name or in the name of Agent as agent and attorney-in-fact for Borrower. Borrower shall protect and defend Borrower's title to the Collateral and Agent's Lien thereon against all Persons claiming any interest adverse to Borrower or Agent other than Permitted Liens.

7.4 Indebtedness. Borrower shall not create, incur, assume, guarantee or be or remain liable with respect to any Indebtedness, or permit any Subsidiary so to do, other than Permitted Indebtedness, or prepay any Indebtedness or take any actions which impose on Borrower an obligation to prepay any Indebtedness, except for (a) the conversion of Indebtedness into equity securities and the payment of cash in lieu of fractional shares in connection with such conversion, (b) purchase money Indebtedness pursuant to its then applicable payment schedule, (c) prepayment by any Subsidiary of (i) inter-company Indebtedness owed by such Subsidiary to any Borrower, or (ii) if such Subsidiary is not a Borrower, intercompany Indebtedness owed by such Subsidiary to another Subsidiary that is not a Borrower, or (d) as otherwise permitted hereunder or approved in writing by Agent.

7.5 Collateral. Borrower shall at all times keep the Collateral, the Intellectual Property and all other property and assets used in Borrower's business or in which

Borrower now or hereafter holds any interest free and clear from any legal process or Liens whatsoever (except for Permitted Liens), and shall give Agent prompt written notice of any legal process affecting the Collateral, the Intellectual Property, such other property and assets, or any Liens thereon, provided however, that the Collateral and such other property and assets may be subject to Permitted Liens except that there shall be no Liens whatsoever on Intellectual Property other than (i) customary restrictions on assignment, sublicense or transfer that may exist in any license agreement where Borrower or a Subsidiary is the licensee (and not the licensor) and (ii) licenses of Intellectual Property that constitute Permitted Transfers. Borrower shall not agree with any Person other than Agent or Lender not to encumber its property other than pursuant to customary restrictions in leases, licenses and agreements in respect of Permitted Indebtedness. Borrower shall not enter into or suffer to exist or become effective any agreement that prohibits or limits the ability of any Borrower to create, incur, assume or suffer to exist any Lien upon any of its Intellectual Property, whether now owned or hereafter acquired, to secure its obligations under the Loan Documents to which it is a party other than (a) this Agreement and the other Loan Documents, (b) any agreements governing any purchase money Liens or capital lease obligations otherwise permitted hereby (in which case, any prohibition or limitation shall only be effective against the assets financed thereby) and (c) customary restrictions on the assignment of leases, licenses and other agreements. Borrower shall cause its Subsidiaries to protect and defend such Subsidiary's title to its assets from and against all Persons claiming any interest adverse to such Subsidiary, and Borrower shall cause its Subsidiaries at all times to keep such Subsidiary's property and assets free and clear from any legal process or Liens whatsoever (except for Permitted Liens, provided however, that there shall be no Liens whatsoever on Intellectual Property other than (i) customary restrictions on assignment, sublicense or transfer that may exist in any license agreement where Borrower or a Subsidiary is the licensee (and not the licensor) and (ii) licenses of Intellectual Property that constitute Permitted Transfers), and shall give Agent prompt written notice of any legal process affecting such Subsidiary's assets.

7.6 Investments. Borrower shall not directly or indirectly acquire or own, or make any Investment in or to any Person, or permit any of its Subsidiaries to do so, other than Permitted Investments.

7.7 Distributions. Borrower shall not, and shall not allow any Subsidiary to, (a) repurchase or redeem any class of stock or other Equity Interest other than pursuant to employee, director or consultant repurchase plans or other similar agreements, provided, however, in each case the repurchase or redemption price does not exceed the original consideration paid for such stock or Equity Interest, or (b) declare or pay any cash dividend or make a cash distribution on any class of stock or other Equity Interest, except that a Subsidiary may pay dividends or make distributions to Borrower, or (c) lend money to any employees, officers or directors (except for Permitted Investments) or guarantee the payment of any such loans granted by a third party in excess of \$250,000 in the aggregate or (d) waive, release or forgive any Indebtedness owed by any employees, officers or directors in excess of \$250,000 in the aggregate.

7.8 Transfers. Except for Permitted Transfers, Borrower shall not, and shall not allow any Subsidiary to, voluntarily or involuntarily transfer, sell, lease, license, lend or in any other manner convey any equitable, beneficial or legal interest in any material portion of its assets.

7.9 Mergers or Acquisitions. Borrower shall not merge or consolidate, or permit any of its Subsidiaries to merge or consolidate, with or into any other business organization (other than mergers or consolidations of (a) a Subsidiary which is not a Borrower into another Subsidiary or into Borrower or (b) a Borrower into another Borrower), or acquire, or permit any of its Subsidiaries to acquire, in each case including for the avoidance of doubt through a merger, purchase, in-licensing arrangement or any similar transaction, all or substantially all of the capital stock or any property of another Person, other than in connection with a Permitted Investment or Permitted Acquisition.

7.10 Taxes. Borrower and its Subsidiaries shall pay when due all material taxes, fees or other charges of any nature whatsoever (together with any related interest or penalties) now or hereafter imposed or assessed against Borrower, Agent, Lender or the Collateral or upon Borrower's ownership, possession, use, operation or disposition thereof or upon Borrower's rents, receipts or earnings arising therefrom. Borrower shall file on or before the due date therefor all personal property tax returns in respect of the Collateral. Notwithstanding the foregoing, Borrower may contest, in good faith and by appropriate proceedings, taxes for which Borrower maintains adequate reserves therefor in accordance with GAAP.

7.11 Corporate Changes. Neither Borrower nor any Subsidiary shall change its corporate name, legal form or jurisdiction of formation without twenty (20) days' prior written notice to Agent. Neither Borrower nor any Subsidiary shall suffer a Change in Control. Neither Borrower nor any Subsidiary shall relocate its chief executive office or its principal place of business unless: (i) it has provided prior written notice to Agent; and (ii) such relocation shall be within the continental United States of America. Neither Borrower nor any Qualified Subsidiary shall relocate any item of Collateral (other than (x) sales of Inventory in the ordinary course of business, (y) relocations of Equipment having an aggregate value of up to \$250,000 in any fiscal year, and (z) relocations of Collateral from a location described on Exhibit C to another location described on Exhibit C) unless (i) it has provided prompt written notice to Agent, (ii) such relocation is within the continental United States of America and, (iii) if such relocation is to a third party bailee, it has delivered a bailee agreement in form and substance reasonably acceptable to Agent.

7.12 Deposit Accounts. Neither Borrower nor any Qualified Subsidiary shall maintain any Deposit Accounts, or accounts holding Investment Property, except (i) for Excluded Accounts, or (ii) with respect to which Agent has an Account Control Agreement. Notwithstanding anything to the contrary in this Agreement, the Excluded Subsidiary may maintain Deposit Accounts which are not subject to an Account Control Agreement, provided that the aggregate amount in such Deposit Accounts does not at any time exceed \$5,000,000, provided, however, that Borrower at all times shall be in compliance with the provisions of Section 7.21 below.

7.13 Notification of New Subsidiaries. Borrower shall notify Agent of each Subsidiary formed subsequent to the Closing Date and, within 15 days of formation, shall cause any such Qualified Subsidiary to execute and deliver to Agent a Joinder Agreement.

7.14 [Reserved].

7.15 Notification of Event of Default. Borrower shall notify Agent immediately of the occurrence of any Event of Default.

7.16 Use of Proceeds. Borrower agrees that the proceeds of the Loans shall be used solely to refinance existing indebtedness, to pay related fees and expenses in connection with this Agreement and for working capital and general corporate purposes, including strategic licensing and acquisition opportunities permitted under this Agreement or consented to by Agent. The proceeds of the Loans will not be used in violation of Anti-Corruption Laws or applicable Sanctions.

7.17 Foreign Subsidiary Voting Rights. Borrower shall not, and shall not permit any Subsidiary, to amend or modify any governing document of any Foreign Subsidiary of Borrower (other than an Eligible Foreign Subsidiary) the effect of which is to require a vote of greater than 50.1% of the Equity Interests or voting rights of such entity for any decision or action of such entity.

7.18 Compliance with Laws.

Borrower shall maintain, and shall cause its Subsidiaries to maintain, compliance in all material respects with all applicable laws, rules or regulations (including any law, rule or regulation with respect to the making or brokering of loans or financial accommodations), and shall, or cause its Subsidiaries to, obtain and maintain all required governmental authorizations, approvals, licenses, franchises, permits or registrations reasonably necessary in connection with the conduct of Borrower's business.

Neither Borrower nor any of its Subsidiaries shall, nor shall Borrower or any of its Subsidiaries permit any Affiliate controlled by Borrower or any Subsidiary to, directly or indirectly, knowingly enter into any documents, instruments, agreements or contracts with any Person listed on the OFAC Lists. Neither Borrower nor any of its Subsidiaries shall, nor shall Borrower or any of its Subsidiaries, permit any Affiliate controlled by Borrower or any Subsidiary to, directly or indirectly, (i) conduct any business or engage in any transaction or dealing with any Blocked Person, including, without limitation, the making or receiving of any contribution of funds, goods or services to or for the benefit of any Blocked Person, (ii) deal in, or otherwise engage in any transaction relating to, any property or interests in property blocked pursuant to Executive Order No. 13224 or any similar executive order or other Anti-Terrorism Law, or (iii) engage in or conspire to engage in any transaction that evades or avoids, or has the purpose of evading or avoiding, or attempts to violate, any of the prohibitions set forth in Executive Order No. 13224 or other Anti-Terrorism Law.

Borrower has implemented and maintains in effect policies and procedures designed to ensure compliance by the Borrower, its Subsidiaries and their respective directors, officers, employees and agents with Anti-Corruption Laws and applicable Sanctions, and Borrower and its Subsidiaries and their respective officers and employees and to the knowledge of Borrower, its directors and agents, are in compliance with Anti-Corruption Laws and applicable Sanctions in all material respects.

None of Borrower, any of its Subsidiaries or any of their respective directors, officers or employees, or to the knowledge of Borrower, any agent for Borrower or its Subsidiaries that will act in any capacity in connection with or benefit from the credit facility established hereby, is a Sanctioned Person. No Loan, use of proceeds or other transaction contemplated by this Agreement will violate Anti-Corruption Laws or applicable Sanctions.

7.19 Intellectual Property. Each Borrower shall protect, defend and maintain the validity and enforceability of its Intellectual Property material to its business; (ii) promptly advise Agent in writing of material infringements of its Intellectual Property; and (iii) not allow any Intellectual Property material to Borrowers' business to be abandoned, forfeited or dedicated to the public without Agent's written consent. If a Borrower (i) obtains any Patent, registered Trademark, registered Copyright, registered mask work, or any pending application for any of the foregoing, whether as owner, licensee or otherwise, or (ii) applies for any Patent or the registration of any Trademark, then such Borrower shall promptly, and in any event, within thirty (30) days thereof, provide written notice thereof to Agent. If a Borrower decides to register any Copyrights or mask works in the United States Copyright Office, such Borrower shall provide Agent with at least fifteen (15) days prior written notice of such Borrower's intent to register such Copyrights or mask works together with a copy of the application it intends to file with the United States Copyright Office (excluding exhibits thereto). Borrowers shall promptly provide to Agent copies of all applications that it files for Patents or for the registration of Trademarks, Copyrights or mask works.

7.20 Transactions with Affiliates. Borrower shall not and shall not permit any Subsidiary to, directly or indirectly, enter into or permit to exist any transaction of any kind with any Affiliate of Borrower or such Subsidiary on terms that are less favorable to Borrower or such Subsidiary, as the case may be, than those that might be obtained in an arm's length transaction from a Person who is not an Affiliate of Borrower or such Subsidiary.

7.21 Minimum Cash.

(a) Borrower shall at all times prior to the Approval Milestone Date, maintain Qualified Cash in an aggregate amount greater than or equal to Twenty Million Dollars (\$20,000,000);

(b) Notwithstanding the provisions of Section 7.21(a) above, Borrower shall at all times on and after the Approval Milestone Date, maintain Qualified Cash in an aggregate amount greater than or equal Ten Million Dollars (\$10,000,000).

(c) Notwithstanding the foregoing, in the event of any Permitted Acquisition, the minimum Cash levels set forth in this Section 7.21 may be reset, subject to Agent's discretion.

7.22 Performance Covenant.

(a) Subject to Section 7.22(b), from and after January 31, 2025, Borrower shall maintain T6M Net Product Revenue, tested monthly, of at least 55% of Net Product Revenue Forecast.

(b) The requirement in Section 7.22(a) shall be waived during any period for which either (i) Borrower maintains Qualified Cash in an amount equal to or greater than 80% of the aggregate principal amount of Term Loan Advances outstanding under this Agreement or (ii) both (x) Company maintains a Market Capitalization of at least \$500,000,000 and (y) Borrower maintains Qualified Cash in an amount equal to at least 50% of the aggregate principal amount of Term Loan Advances outstanding under this Agreement (for the avoidance of doubt, this waiver provision is a daily condition and, if it is not satisfied at any point in time, compliance with Section 7.22(a) would need to be demonstrated as of the most recent financial reporting period).

7.23 Security Corporation Investment Conditions. At any time that the Security Corporation Subsidiary has any assets or liabilities, Borrower shall satisfy the Security Corporation Investment Conditions at all times.

7.24 Post-Closing Items. On or before the corresponding dates set forth on Schedule 7.24, Borrower shall use its commercially reasonable efforts to deliver or cause to be delivered or completed the items listed on Schedule 7.24.

SECTION 8. RIGHT TO INVEST

8.1 The Lenders or their assignee or nominee shall have the right, in its discretion, to participate, in a cumulative amount of up to \$1,000,000 in the aggregate, in one or more Subsequent Financings, on the same terms, conditions and pricing afforded to others participating in any such Subsequent Financing, provided, however, Lender or its assignee or nominee agrees to become a party to the agreements executed by the others participating in such Subsequent Financing. Notwithstanding the foregoing, the Company shall provide the Lender or its assignee or nominee at least one (1) Business Days' notice (which may be oral) of a planned Subsequent Financing and the opportunity to exercise the right to invest under this Section 8.1 with respect to such Subsequent Financing. This Section 8.1, and all rights and obligations hereunder, shall terminate upon the earlier to occur of (i) such time that the Lender or its assignees or nominees have purchased \$1,000,000 of the Company's equity securities in the aggregate in any Subsequent

Financing(s) and (ii) the later to occur of (A) the repayment of the Indebtedness under this Agreement and (B) the exercise in full of the Warrants or the expiration or termination of the exercise period for the Warrants.

SECTION 9. EVENTS OF DEFAULT

The occurrence of any one or more of the following events shall be an Event of Default:

9.1 Payments. Borrower fails to pay any amount due under this Agreement or any of the other Loan Documents on the due date; provided, however, that an Event of Default shall not occur on account of a failure to pay due solely to an administrative or operational error of Agent or the Lenders or Borrower's bank if Borrower had the funds to make the payment when due and makes the payment within three (3) Business Days following Borrower's knowledge of such failure to pay; or

9.2 Covenants. Borrower breaches or defaults in the performance of any covenant or Secured Obligation under this Agreement, or any of the other Loan Documents or any other agreement among Borrower, Agent and the Lenders, and (a) with respect to a default under any covenant under this Agreement (other than under Sections 6, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 7.15, 7.16, 7.17, 7.18, 7.19, 7.21, 7.22, 7.23 and 7.24) any other Loan Document or any other agreement among Borrower, Agent and the Lenders, such default continues for more than ten (10) Business Days after the earlier of the date on which (i) Agent or the Lenders has given notice of such default to Borrower and (ii) Borrower has actual knowledge of such default or (b) with respect to a default under any of Sections 6, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 7.15, 7.16, 7.17, 7.18, 7.19, 7.21, 7.22, 7.23 and 7.24, the occurrence of such default; or

9.3 Material Adverse Effect. A circumstance has occurred that could reasonably be expected to have a Material Adverse Effect; or

9.4 Representations. Any representation or warranty made by Borrower in any Loan Document shall have been false or misleading in any material respect when made or when deemed made; or

9.5 Insolvency. Borrower (A) (i) shall make an assignment for the benefit of creditors; or (ii) shall be unable to pay its debts as they become due, or be unable to pay or perform under the Loan Documents, or shall become insolvent; or (iii) shall file a voluntary petition in bankruptcy; or (iv) shall file any petition, answer, or document seeking for itself any reorganization, arrangement, composition, readjustment, liquidation, dissolution or similar relief under any present or future statute, law or regulation pertinent to such circumstances; or (v) shall seek or consent to or acquiesce in the appointment of any trustee, receiver, or liquidator of Borrower or of all or any substantial part (i.e., 33-1/3% or more) of the assets or property of Borrower; or (vi) shall cease operations of its business as its business has normally been conducted, or terminate substantially all of its employees; or (vii) Borrower or its directors or majority shareholders shall take any action initiating any of the foregoing actions described in clauses (i) through (vi); or (B) either (i)

forty-five (45) days shall have expired after the commencement of an involuntary action against Borrower seeking reorganization, arrangement, composition, readjustment, liquidation, dissolution or similar relief under any present or future statute, law or regulation, without such action being dismissed or all orders or proceedings thereunder affecting the operations or the business of Borrower being stayed; or (ii) a stay of any such order or proceedings shall thereafter be set aside and the action setting it aside shall not be timely appealed; or (iii) Borrower shall file any answer admitting or not contesting the material allegations of a petition filed against Borrower in any such proceedings; or (iv) the court in which such proceedings are pending shall enter a decree or order granting the relief sought in any such proceedings; or (v) forty-five (45) days shall have expired after the appointment, without the consent or acquiescence of Borrower, of any trustee, receiver or liquidator of Borrower or of all or any substantial part of the properties of Borrower without such appointment being vacated; or

9.6 Attachments; Judgments. Any portion of Borrower's assets is attached or seized, or a levy is filed against any such assets, or a judgment or judgments is/are entered for the payment of money (not covered by independent third party insurance as to which liability has not been rejected by such insurance carrier), individually or in the aggregate, of at least \$500,000, or Borrower is enjoined or in any way prevented by court order from conducting a material part of its business and such attachment, seizure, levy, judgment or enjoinder is not, within thirty (30) days after the occurrence thereof, discharged or stayed (whether through the posting of a bond or otherwise); or

9.7 Other Obligations. The occurrence of any "event of default" under any agreement or obligation of Borrower involving any Indebtedness in excess of \$500,000 after giving effect to any applicable grace period thereunder which results in a right by such third party to accelerate the maturity of such Indebtedness.

SECTION 10. REMEDIES

10.1 General. Upon and during the continuance of any one or more Events of Default, (i) Agent may, and at the direction of the Required Lenders shall, accelerate and demand payment of all or any part of the Secured Obligations together with a Prepayment Charge and declare them to be immediately due and payable (provided, that upon the occurrence of an Event of Default of the type described in Section 9.5, all of the Secured Obligations (including, without limitation, the Prepayment Charge and the End of Term Charge) shall automatically be accelerated and made due and payable, in each case without any further notice or act). Borrower hereby irrevocably appoints Agent as its lawful attorney-in-fact to: (a) exercisable following the occurrence and during the continuance of an Event of Default, (i) sign Borrower's name on any invoice or bill of lading for any account or drafts against account debtors; (ii) demand, collect, sue, and give releases to any account debtor for monies due, settle and adjust disputes and claims about the accounts directly with account debtors, and compromise, prosecute, or defend any action, claim, case, or proceeding about any Collateral (including filing a claim or voting a claim in any bankruptcy case in Agent's or Borrower's name, as Agent may elect); (iii) make, settle, and adjust all claims under Borrower's insurance policies; (iv) pay, contest or

settle any Lien, charge, encumbrance, security interest, or other claim in or to the Collateral, or any judgment based thereon, or otherwise take any action to terminate or discharge the same; (v) transfer the Collateral into the name of Agent or a third party as the UCC permits; and (vi) receive, open and dispose of mail addressed to Borrower; and (b) regardless of whether an Event of Default has occurred, (i) endorse Borrower's name on any checks, payment instruments, or other forms of payment or security; and (ii) notify all account debtors to pay Agent directly. Borrower hereby appoints Agent as its lawful attorney-in-fact to sign Borrower's name on any documents necessary to perfect or continue the perfection of Agent's security interest in the Collateral regardless of whether an Event of Default has occurred until all Secured Obligations have been satisfied in full and the Loan Documents have been terminated. Agent's foregoing appointment as Borrower's attorney in fact, and all of Agent's rights and powers, coupled with an interest, are irrevocable until all Secured Obligations have been fully repaid and performed and the Loan Documents have been terminated. Agent may, and at the direction of the Required Lenders shall, exercise all rights and remedies with respect to the Collateral under the Loan Documents or otherwise available to it under the UCC and other applicable law, including the right to release, hold, sell, lease, liquidate, collect, realize upon, or otherwise dispose of all or any part of the Collateral and the right to occupy, utilize, process and commingle the Collateral. All Agent's rights and remedies shall be cumulative and not exclusive.

10.2 Collection; Foreclosure. Upon the occurrence and during the continuance of any Event of Default, Agent may, and at the direction of the Required Lenders shall, at any time or from time to time, apply, collect, liquidate, sell in one or more sales, lease or otherwise dispose of, any or all of the Collateral, in its then condition or following any commercially reasonable preparation or processing, in such order as Agent may elect. Any such sale may be made either at public or private sale at its place of business or elsewhere. Borrower agrees that any such public or private sale may occur upon ten (10) calendar days' prior written notice to Borrower. Agent may require Borrower to assemble the Collateral and make it available to Agent at a place designated by Agent that is reasonably convenient to Agent and Borrower. The proceeds of any sale, disposition or other realization upon all or any part of the Collateral shall be applied by Agent in the following order of priorities:

First, to Agent and the Lenders in an amount sufficient to pay in full Agent's and the Lenders' reasonable costs and professionals' and advisors' fees and expenses as described in Section 11.11;

Second, to the Lenders in an amount equal to the then unpaid amount of the Secured Obligations (including principal, interest, and the Default Rate interest), in such order and priority as Agent may choose in its sole discretion; and

Finally, after the full and final payment in Cash of all of the Secured Obligations (other than inchoate obligations), to any creditor holding a junior Lien on the Collateral, or to Borrower or its representatives or as a court of competent jurisdiction may direct.

Agent shall be deemed to have acted reasonably in the custody, preservation and disposition of any of the Collateral if it complies with the obligations of a secured party under the UCC.

10.3 No Waiver. Agent shall be under no obligation to marshal any of the Collateral for the benefit of Borrower or any other Person, and Borrower expressly waives all rights, if any, to require Agent to marshal any Collateral.

10.4 Cumulative Remedies. The rights, powers and remedies of Agent hereunder shall be in addition to all rights, powers and remedies given by statute or rule of law and are cumulative. The exercise of any one or more of the rights, powers and remedies provided herein shall not be construed as a waiver of or election of remedies with respect to any other rights, powers and remedies of Agent.

SECTION 11. MISCELLANEOUS

11.1 Severability. Whenever possible, each provision of this Agreement shall be interpreted in such manner as to be effective and valid under applicable law, but if any provision of this Agreement shall be prohibited by or invalid under such law, such provision shall be ineffective only to the extent and duration of such prohibition or invalidity, without invalidating the remainder of such provision or the remaining provisions of this Agreement.

11.2 Notice. Except as otherwise provided herein, any notice, demand, request, consent, approval, declaration, service of process or other communication (including the delivery of Financial Statements) that is required, contemplated, or permitted under the Loan Documents or with respect to the subject matter hereof shall be in writing, and shall be deemed to have been validly served, given, delivered, and received upon the earlier of: (i) the day of transmission by electronic mail or hand delivery or delivery by an overnight express service or overnight mail delivery service; or (ii) the third calendar day after deposit in the United States of America mails, with proper first class postage prepaid, in each case addressed to the party to be notified as follows:

(a) If to Agent:

HERCULES CAPITAL, INC.
Legal Department
Attention: Chief Legal Officer and Bryan Jadot
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301
email:
Telephone:

(b) If to the Lenders:

HERCULES CAPITAL, INC.
Legal Department

Attention: Chief Legal Officer and Bryan Jadot
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301
email:
Telephone:

(c) If to Borrower:

X4 PHARMACEUTICALS, INC.

Attention: Adam Mostafa and Brian Bowersox
61 North Beacon Street, 4th Floor
Boston, MA 02134
email:
Telephone:

Cooley LLP
55 Hudson Yards
New York, NY 10001
Email: cmusa@cooley.com
Telephone: 212-479-6000

or to such other address as each party may designate for itself by like notice.

11.3 Entire Agreement; Amendments.

(a) This Agreement and the other Loan Documents constitute the entire agreement and understanding of the parties hereto in respect of the subject matter hereof and thereof, and supersede and replace in their entirety any prior proposals, term sheets, non-disclosure or confidentiality agreements, letters, negotiations or other documents or agreements, whether written or oral, with respect to the subject matter hereof or thereof (including Agent's revised proposal letter dated December 13, 2022 and the Non-Disclosure Agreement). For the avoidance of doubt, all security interests granted under the Original Agreement and the Original A&R LSA are hereby confirmed and ratified and shall continue to secure all Secured Obligations under this Agreement. None of the terms of this Agreement or any of the other Loan Documents may be amended except by an instrument executed by each of the parties hereto.

(b) Neither this Agreement, any other Loan Document, nor any terms hereof or thereof may be amended, supplemented or modified except in accordance with the provisions of this Section 11.3(b). The Required Lenders and Borrower party to the relevant Loan Document may, or, with the written consent of the Required Lenders, the Agent and the Borrower party to the relevant Loan Document may, from time to time, (i) enter into written amendments, supplements or modifications hereto and to the other Loan Documents for the purpose of adding any provisions to this Agreement or the other Loan Documents or changing in any manner the rights of the Lenders or of the Borrower hereunder or thereunder or (ii) waive, on such terms and conditions as the Required

Lenders or the Agent, as the case may be, may specify in such instrument, any of the requirements of this Agreement or the other Loan Documents or any default or Event of Default and its consequences; provided, however, that no such waiver and no such amendment, supplement or modification shall (A) forgive the principal amount, extend the final scheduled date of maturity of any Loan, extend the scheduled date of any amortization payment in respect of any Term Loan, or reduce the stated rate of any interest or fee payable hereunder, in each case without the written consent of each Lender directly affected thereby; (B) eliminate or reduce the voting rights of any Lender under this Section 11.3(b) without the written consent of such Lender; (C) reduce any percentage specified in the definition of Required Lenders, consent to the assignment or transfer by the Borrower of any of its rights and obligations under this Agreement and the other Loan Documents, release all or substantially all of the Collateral or release a Borrower from its obligations under the Loan Documents, in each case without the written consent of all Lenders; or (D) amend, modify or waive any provision of Section 11.17 without the written consent of the Agent. Any such waiver and any such amendment, supplement or modification shall apply equally to each Lender and shall be binding upon Borrower, the Lender, the Agent and all future holders of the Loans.

11.4 No Strict Construction. The parties hereto have participated jointly in the negotiation and drafting of this Agreement. In the event an ambiguity or question of intent or interpretation arises, this Agreement shall be construed as if drafted jointly by the parties hereto and no presumption or burden of proof shall arise favoring or disfavoring any party by virtue of the authorship of any provisions of this Agreement.

11.5 No Waiver. The powers conferred upon Agent and the Lenders by this Agreement are solely to protect its rights hereunder and under the other Loan Documents and its interest in the Collateral and shall not impose any duty upon Agent or the Lenders to exercise any such powers. No omission or delay by Agent or the Lenders at any time to enforce any right or remedy reserved to it, or to require performance of any of the terms, covenants or provisions hereof by Borrower at any time designated, shall be a waiver of any such right or remedy to which Agent or the Lenders is entitled, nor shall it in any way affect the right of Agent or the Lenders to enforce such provisions thereafter.

11.6 Survival. All agreements, representations and warranties contained in this Agreement and the other Loan Documents or in any document delivered pursuant hereto or thereto shall be for the benefit of Agent and the Lenders and shall survive the execution and delivery of this Agreement. Sections 6.3, 8.1 and 11.14 shall survive the termination of this Agreement.

11.7 Successors and Assigns. The provisions of this Agreement and the other Loan Documents shall inure to the benefit of and be binding on Borrower and its permitted assigns (if any). Borrower shall not assign its obligations under this Agreement or any of the other Loan Documents without Agent's express prior written consent, and any such attempted assignment shall be void and of no effect. Agent and the Lenders may assign, transfer, or endorse its rights hereunder and under the other Loan Documents without prior notice to Borrower, and all of such rights shall inure to the benefit of

Agent's and the Lenders' successors and assigns; provided that as long as no Event of Default has occurred and is continuing, neither Agent nor any Lender may assign, transfer or endorse its rights hereunder or under the Loan Documents to any party that is a direct competitor of Borrower (as reasonably determined by Agent), it being acknowledged that in all cases, any transfer to an Affiliate of any Lender or Agent shall be allowed. Notwithstanding the foregoing, (x) in connection with any assignment by a Lender as a result of a forced divestiture at the request of any regulatory agency, the restrictions set forth herein shall not apply and Agent and the Lenders may assign, transfer or indorse its rights hereunder and under the other Loan Documents to any Person or party and (y) in connection with a Lender's own financing or securitization transactions, the restrictions set forth herein shall not apply and Agent and the Lenders may assign, transfer or indorse its rights hereunder and under the other Loan Documents to any Person or party providing such financing or formed to undertake such securitization transaction and any transferee of such Person or party upon the occurrence of a default, event of default or similar occurrence with respect to such financing or securitization transaction; provided that no such sale, transfer, pledge or assignment under this clause (y) shall release such Lender from any of its obligations hereunder or substitute any such Person or party for such Lender as a party hereto until Agent shall have received and accepted an effective assignment agreement from such Person or party in form satisfactory to Agent executed, delivered and fully completed by the applicable parties thereto, and shall have received such other information regarding such assignee as Agent reasonably shall require. The Agent, acting solely for this purpose as an agent of the Borrower, shall maintain at one of its offices in the United States a register for the recordation of the names and addresses of the Lender(s), and the Term Commitments of, and principal amounts (and stated interest) of the Loans owing to, each Lender pursuant to the terms hereof from time to time (the "Register"). The entries in the Register shall be conclusive absent manifest error, and the Borrower, the Agent and the Lender(s) shall treat each Person whose name is recorded in the Register pursuant to the terms hereof as a Lender hereunder for all purposes of this Agreement. The Register shall be available for inspection by the Borrower and any Lender, at any reasonable time and from time to time upon reasonable prior notice.

11.8 Governing Law. This Agreement and the other Loan Documents have been negotiated and delivered to Agent and the Lenders in the State of California, and shall have been accepted by Agent and the Lenders in the State of California. Payment to Agent and the Lenders by Borrower of the Secured Obligations is due in the State of California. This Agreement and the other Loan Documents shall be governed by, and construed and enforced in accordance with, the laws of the State of California, excluding conflict of laws principles that would cause the application of laws of any other jurisdiction.

11.9 Consent to Jurisdiction and Venue. All judicial proceedings (to the extent that the reference requirement of Section 11.10 is not applicable) arising in or under or related to this Agreement or any of the other Loan Documents may be brought in any state or federal court located in the State of California. By execution and delivery of this Agreement, each party hereto generally and unconditionally: (a) consents to nonexclusive personal jurisdiction in Santa Clara County, State of California; (b) waives any objection

as to jurisdiction or venue in Santa Clara County, State of California; (c) agrees not to assert any defense based on lack of jurisdiction or venue in the aforesaid courts; and (d) irrevocably agrees to be bound by any judgment rendered thereby in connection with this Agreement or the other Loan Documents. Service of process on any party hereto in any action arising out of or relating to this Agreement shall be effective if given in accordance with the requirements for notice set forth in Section 11.2, and shall be deemed effective and received as set forth in Section 11.2. Nothing herein shall affect the right to serve process in any other manner permitted by law or shall limit the right of either party to bring proceedings in the courts of any other jurisdiction.

11.10 Mutual Waiver of Jury Trial / Judicial Reference.

(a) Because disputes arising in connection with complex financial transactions are most quickly and economically resolved by an experienced and expert Person and the parties wish applicable state and federal laws to apply (rather than arbitration rules), the parties desire that their disputes be resolved by a judge applying such applicable laws. EACH OF BORROWER, AGENT AND THE LENDERS SPECIFICALLY WAIVES ANY RIGHT IT MAY HAVE TO TRIAL BY JURY OF ANY CAUSE OF ACTION, CLAIM, CROSS-CLAIM, COUNTERCLAIM, THIRD PARTY CLAIM OR ANY OTHER CLAIM (COLLECTIVELY, "CLAIMS") ASSERTED BY BORROWER AGAINST AGENT, THE LENDERS OR THEIR RESPECTIVE ASSIGNEE OR BY AGENT, THE LENDERS OR THEIR RESPECTIVE ASSIGNEE AGAINST BORROWER. This waiver extends to all such Claims, including Claims that involve Persons other than Agent, Borrower and the Lenders; Claims that arise out of or are in any way connected to the relationship among Borrower, Agent and the Lenders; and any Claims for damages, breach of contract, tort, specific performance, or any equitable or legal relief of any kind, arising out of this Agreement, any other Loan Document.

(b) If the waiver of jury trial set forth in Section 11.10(a) is ineffective or unenforceable, the parties agree that all Claims shall be resolved by reference to a private judge sitting without a jury, pursuant to Code of Civil Procedure Section 638, before a mutually acceptable referee or, if the parties cannot agree, a referee selected by the Presiding Judge of the Santa Clara County, California. Such proceeding shall be conducted in Santa Clara County, California, with California rules of evidence and discovery applicable to such proceeding.

(c) In the event Claims are to be resolved by judicial reference, either party may seek from a court identified in Section 11.9, any prejudgment order, writ or other relief and have such prejudgment order, writ or other relief enforced to the fullest extent permitted by law notwithstanding that all Claims are otherwise subject to resolution by judicial reference.

11.11 Professional Fees. Borrower promises to pay Agent's and the Lenders' reasonable and documented fees and expenses necessary to finalize the loan documentation, including but not limited to reasonable and documented attorneys' fees, UCC searches, filing costs, and other miscellaneous expenses. In addition, Borrower

promises to pay any and all reasonable and documented attorneys' and other professionals' fees and expenses incurred by Agent and the Lenders after the Closing Date in connection with or related to: (a) the Loan; (b) the administration, collection, or enforcement of the Loan; (c) the amendment or modification of the Loan Documents; (d) any waiver, consent, release, or termination under the Loan Documents; (e) the protection, preservation, audit, field exam, sale, lease, liquidation, or disposition of Collateral or the exercise of remedies with respect to the Collateral; (f) any legal, litigation, administrative, arbitration, or out of court proceeding in connection with or related to Borrower or the Collateral, and any appeal or review thereof; and (g) any bankruptcy, restructuring, reorganization, assignment for the benefit of creditors, workout, foreclosure, or other action related to Borrower, the Collateral, the Loan Documents, including representing Agent or the Lenders in any adversary proceeding or contested matter commenced or continued by or on behalf of Borrower's estate, and any appeal or review thereof.

11.12 Confidentiality. Agent and the Lenders acknowledge that certain items of Collateral and information provided to Agent and the Lenders, including items provided in connection with the Non-Disclosure Agreement, by Borrower are confidential and proprietary information of Borrower, if and to the extent such information either (x) is marked as confidential by Borrower at the time of disclosure, or (y) should reasonably be understood to be confidential (the "Confidential Information"). Accordingly, Agent and the Lenders agree that any Confidential Information it may obtain during the term of this Agreement shall not be disclosed to any other Person or entity in any manner whatsoever, in whole or in part, without the prior written consent of Borrower, except that Agent and Lenders may disclose any such information: (a) to its own directors, officers, employees, accountants, counsel and other professional advisors and to its Affiliates if Agent or Lenders in their sole discretion determines that any such party should have access to such information in connection with such party's responsibilities in connection with the Loan or this Agreement and, provided that such recipient of such Confidential Information either (i) agrees to be bound by the confidentiality provisions of this paragraph or (ii) is otherwise subject to confidentiality restrictions that reasonably protect against the disclosure of Confidential Information; (b) if such information is generally available to the public through no fault of Agent or Lenders; (c) if required or appropriate in any report, statement or testimony submitted to any governmental authority having or claiming to have jurisdiction over Agent or Lenders; (d) if required or appropriate in response to any summons or subpoena or in connection with any litigation, to the extent permitted or deemed advisable by Agent's or Lenders' counsel; (e) to comply with any legal requirement or law applicable to Agent or Lenders; (f) to the extent reasonably necessary in connection with the exercise of any right or remedy under any Loan Document, including Agent's sale, lease, or other disposition of Collateral after an Event of Default; (g) to any participant or assignee of Agent or Lenders or any prospective participant or assignee; provided, that such participant or assignee or prospective participant or assignee agrees in writing to be bound by this Section 11.12 prior to disclosure; or (h) otherwise with the prior consent of Borrower; provided, that any disclosure made in violation of this Agreement shall not affect the obligations of Borrower or any of its Affiliates or any

guarantor under this Agreement or the other Loan Documents. Agent's and Lenders' obligations under this Section 11.12 shall supersede all of their respective obligations under the Non-Disclosure Agreement.

11.13 Assignment of Rights. Borrower acknowledges and understands that Agent or the Lenders may, subject to Section 11.7, sell and assign all or part of its interest hereunder and under the Loan Documents to any Person or entity (an "Assignee"). After such assignment the term "Agent" or "Lender" as used in the Loan Documents shall mean and include such Assignee, and such Assignee shall be vested with all rights, powers and remedies of Agent and the Lenders hereunder with respect to the interest so assigned; but with respect to any such interest not so transferred, Agent and the Lenders shall retain all rights, powers and remedies hereby given. No such assignment by Agent or the Lenders shall relieve Borrower of any of its obligations hereunder. The Lenders agree that in the event of any transfer by it of the Note(s)(if any), it will endorse thereon a notation as to the portion of the principal of the Note(s), which shall have been paid at the time of such transfer and as to the date to which interest shall have been last paid thereon.

11.14 Revival of Secured Obligations. This Agreement and the Loan Documents shall remain in full force and effect and continue to be effective if any petition is filed by or against Borrower for liquidation or reorganization, if Borrower becomes insolvent or makes an assignment for the benefit of creditors, if a receiver or trustee is appointed for all or any significant part of Borrower's assets, or if any payment or transfer of Collateral is recovered from Agent or the Lenders. The Loan Documents and the Secured Obligations and Collateral security shall continue to be effective, or shall be revived or reinstated, as the case may be, if at any time payment and performance of the Secured Obligations or any transfer of Collateral to Agent, or any part thereof is rescinded, avoided or avoidable, reduced in amount, or must otherwise be restored or returned by, or is recovered from, Agent, the Lenders or by any obligee of the Secured Obligations, whether as a "voidable preference," "fraudulent conveyance," or otherwise, all as though such payment, performance, or transfer of Collateral had not been made. In the event that any payment, or any part thereof, is rescinded, reduced, avoided, avoidable, restored, returned, or recovered, the Loan Documents and the Secured Obligations shall be deemed, without any further action or documentation, to have been revived and reinstated except to the extent of the full, final, and indefeasible payment to Agent or the Lenders in Cash.

11.15 Counterparts. This Agreement and any amendments, waivers, consents or supplements hereto may be executed in any number of counterparts, and by different parties hereto in separate counterparts, each of which when so delivered shall be deemed an original, but all of which counterparts shall constitute but one and the same instrument.

11.16 No Third Party Beneficiaries. No provisions of the Loan Documents are intended, nor will be interpreted, to provide or create any third-party beneficiary rights or any other rights of any kind in any Person other than Agent, the Lenders and Borrower unless specifically provided otherwise herein, and, except as otherwise so provided, all provisions of the Loan Documents will be personal and solely among Agent, the Lenders and the Borrower.

11.17 Agency.

(a) Lender hereby irrevocably appoints Hercules Capital, Inc. to act on its behalf as the Agent hereunder and under the other Loan Documents and authorizes the Agent to take such actions on its behalf and to exercise such powers as are delegated to the Agent by the terms hereof or thereof, together with such actions and powers as are reasonably incidental thereto.

(b) Lender agrees to indemnify the Agent in its capacity as such (to the extent not reimbursed by Borrower and without limiting the obligation of Borrower to do so), according to its respective Term Commitment percentages (based upon the total outstanding Term Loan Commitments) in effect on the date on which indemnification is sought under this Section 11.17, from and against any and all liabilities, obligations, losses, damages, penalties, actions, judgments, suits, costs, expenses or disbursements of any kind whatsoever that may at any time be imposed on, incurred by or asserted against the Agent in any way relating to or arising out of, this Agreement, any of the other Loan Documents or any documents contemplated by or referred to herein or therein or the transactions contemplated hereby or thereby or any action taken or omitted by the Agent under or in connection with any of the foregoing; The agreements in this Section shall survive the payment of the Loans and all other amounts payable hereunder.

(c) Agent in Its Individual Capacity. The Person serving as the Agent hereunder shall have the same rights and powers in its capacity as a Lender as any other Lender and may exercise the same as though it were not the Agent and the term "Lender" shall, unless otherwise expressly indicated or unless the context otherwise requires, include each such Person serving as Agent hereunder in its individual capacity.

(d) Exculpatory Provisions. The Agent shall have no duties or obligations except those expressly set forth herein and in the other Loan Documents. Without limiting the generality of the foregoing, the Agent shall not:

- (i) be subject to any fiduciary or other implied duties, regardless of whether any default or any Event of Default has occurred and is continuing;
- (ii) have any duty to take any discretionary action or exercise any discretionary powers, except discretionary rights and powers expressly contemplated hereby or by the other Loan Documents that the Agent is required to exercise as directed in writing by the Lenders, provided that the Agent shall not be required to take any action that, in its opinion or the opinion of its counsel, may expose the Agent to liability or that is contrary to any Loan Document or applicable law; and
- (iii) except as expressly set forth herein and in the other Loan Documents, have any duty to disclose, and the Agent shall not be liable for the failure to disclose, any information relating to the Borrower or any of

its Affiliates that is communicated to or obtained by any Person serving as the Agent or any of its Affiliates in any capacity.

(e) The Agent shall not be liable for any action taken or not taken by it (i) with the consent or at the request of the Lenders or as the Agent shall believe in good faith shall be necessary, under the circumstances or (ii) in the absence of its own gross negligence or willful misconduct.

(f) The Agent shall not be responsible for or have any duty to ascertain or inquire into (i) any statement, warranty or representation made in or in connection with this Agreement or any other Loan Document, (ii) the contents of any certificate, report or other document delivered hereunder or thereunder or in connection herewith or therewith, (iii) the performance or observance of any of the covenants, agreements or other terms or conditions set forth herein or therein or the occurrence of any default or Event of Default, (iv) the validity, enforceability, effectiveness or genuineness of this Agreement, any other Loan Document or any other agreement, instrument or document or (v) the satisfaction of any condition set forth in Section 4 or elsewhere herein, other than to confirm receipt of items expressly required to be delivered to the Agent.

(g) Reliance by Agent. Agent may rely, and shall be fully protected in acting, or refraining to act, upon, any resolution, statement, certificate, instrument, opinion, report, notice, request, consent, order, bond or other paper or document that it has no reason to believe to be other than genuine and to have been signed or presented by the proper party or parties or, in the case of cables, telecopies and telexes, to have been sent by the proper party or parties. In the absence of its gross negligence or willful misconduct, Agent may conclusively rely, as to the truth of the statements and the correctness of the opinions expressed therein, upon any certificates or opinions furnished to Agent and conforming to the requirements of the Agreement or any of the other Loan Documents. Agent may consult with counsel, and any opinion or legal advice of such counsel shall be full and complete authorization and protection in respect of any action taken, not taken or suffered by Agent hereunder or under any Loan Documents in accordance therewith. Agent shall have the right at any time to seek instructions concerning the administration of the Collateral from any court of competent jurisdiction. Agent shall not be under any obligation to exercise any of the rights or powers granted to Agent by this Agreement, the Agreement and the other Loan Documents at the request or direction of Lenders unless Agent shall have been provided by each Lender with adequate security and indemnity against the costs, expenses and liabilities that may be incurred by it in compliance with such request or direction.

11.18 Publicity. None of the parties hereto nor any of its respective member businesses and Affiliates shall, without the other parties' prior written consent (which shall not be unreasonably withheld or delayed), publicize or use (a) the other party's name (including a brief description of the relationship among the parties hereto), logo or hyperlink to such other parties' web site, separately or together, in written and oral presentations, advertising, promotional and marketing materials, client lists, public relations materials or on its web site (together, the "Publicity Materials"); (b) the names of

officers of such other parties in the Publicity Materials; and (c) such other parties' name, trademarks, servicemarks in any news or press release concerning such party; provided however, notwithstanding anything to the contrary herein, no such consent shall be required (i) to the extent necessary to comply with the requests of any regulators, legal requirements or laws applicable to such party, pursuant to any listing agreement with any national securities exchange (so long as such party provides prior notice to the other party hereto to the extent reasonably practicable) and (ii) to comply with Section 11.12.

11.19 Multiple Borrowers.

(a) **Borrower's Agent.** Each of the Borrowers hereby irrevocably appoints the Company as its agent, attorney-in-fact and legal representative for all purposes, including requesting disbursement of the Term Loan and receiving account statements and other notices and communications to Borrowers (or any of them) from the Agent or any Lender. The Agent may rely, and shall be fully protected in relying, on any request for the Term Loan, disbursement instruction, report, information or any other notice or communication made or given by the Company, whether in its own name or on behalf of one or more of the other Borrowers, and the Agent shall not have any obligation to make any inquiry or request any confirmation from or on behalf of any other Borrower as to the binding effect on it of any such request, instruction, report, information, other notice or communication, nor shall the joint and several character of the Borrowers' obligations hereunder be affected thereby.

(b) **Waivers.** Each Borrower hereby waives: (i) any right to require the Agent to institute suit against, or to exhaust its rights and remedies against, any other Borrower or any other person, or to proceed against any property of any kind which secures all or any part of the Secured Obligations, or to exercise any right of offset or other right with respect to any reserves, credits or deposit accounts held by or maintained with the Agent or any Indebtedness of the Agent or any Lender to any other Borrower, or to exercise any other right or power, or pursue any other remedy the Agent or any Lender may have; (ii) any defense arising by reason of any disability or other defense of any other Borrower or any guarantor or any endorser, co-maker or other person, or by reason of the cessation from any cause whatsoever of any liability of any other Borrower or any guarantor or any endorser, co-maker or other person, with respect to all or any part of the Secured Obligations, or by reason of any act or omission of the Agent or others which directly or indirectly results in the discharge or release of any other Borrower or any guarantor or any other person or any Secured Obligations or any security therefor, whether by operation of law or otherwise; (iii) any defense arising by reason of any failure of the Agent to obtain, perfect, maintain or keep in force any Lien on, any property of any Borrower or any other person; (iv) any defense based upon or arising out of any bankruptcy, insolvency, reorganization, arrangement, readjustment of debt, liquidation or dissolution proceeding commenced by or against any other Borrower or any guarantor or any endorser, co-maker or other person, including without limitation any discharge of, or bar against collecting, any of the Secured Obligations (including without limitation any interest thereon), in or as a result of any such proceeding. Until all of the Secured Obligations have been paid, performed, and discharged in full, nothing shall discharge or

satisfy the liability of any Borrower hereunder except the full performance and payment of all of the Secured Obligations. If any claim is ever made upon the Agent for repayment or recovery of any amount or amounts received by the Agent in payment of or on account of any of the Secured Obligations, because of any claim that any such payment constituted a preferential transfer or fraudulent conveyance, or for any other reason whatsoever, and the Agent repays all or part of said amount by reason of any judgment, decree or order of any court or administrative body having jurisdiction over the Agent or any of its property, or by reason of any settlement or compromise of any such claim effected by the Agent with any such claimant (including without limitation the any other Borrower), then and in any such event, each Borrower agrees that any such judgment, decree, order, settlement and compromise shall be binding upon such Borrower, notwithstanding any revocation or release of this Agreement or the cancellation of any note or other instrument evidencing any of the Secured Obligations, or any release of any of the Secured Obligations, and each Borrower shall be and remain liable to the Agent and the Lenders under this Agreement for the amount so repaid or recovered, to the same extent as if such amount had never originally been received by the Agent or any Lender, and the provisions of this sentence shall survive, and continue in effect, notwithstanding any revocation or release of this Agreement. Each Borrower hereby expressly and unconditionally waives all rights of subrogation, reimbursement and indemnity of every kind against any other Borrower, and all rights of recourse to any assets or property of any other Borrower, and all rights to any collateral or security held for the payment and performance of any Secured Obligations, including (but not limited to) any of the foregoing rights which Borrower may have under any present or future document or agreement with any other Borrower or other person, and including (but not limited to) any of the foregoing rights which any Borrower may have under any equitable doctrine of subrogation, implied contract, or unjust enrichment, or any other equitable or legal doctrine.

(c) Consents. Each Borrower hereby consents and agrees that, without notice to or by Borrower and without affecting or impairing in any way the obligations or liability of Borrower hereunder, the Agent may, from time to time before or after revocation of this Agreement, do any one or more of the following in its sole and absolute discretion: (i) accept partial payments of, compromise or settle, renew, extend the time for the payment, discharge, or performance of, refuse to enforce, and release all or any parties to, any or all of the Secured Obligations; (ii) grant any other indulgence to any Borrower or any other Person in respect of any or all of the Secured Obligations or any other matter; (iii) accept, release, waive, surrender, enforce, exchange, modify, impair, or extend the time for the performance, discharge, or payment of, any and all property of any kind securing any or all of the Secured Obligations or any guaranty of any or all of the Secured Obligations, or on which the Agent at any time may have a Lien, or refuse to enforce its rights or make any compromise or settlement or agreement therefor in respect of any or all of such property; (iv) substitute or add, or take any action or omit to take any action which results in the release of, any one or more other Borrowers or any endorsers or guarantors of all or any part of the Secured Obligations, including, without limitation one or more parties to this Agreement, regardless of any

destruction or impairment of any right of contribution or other right of Borrower; (v) apply any sums received from any other Borrower, any guarantor, endorser, or co-signer, or from the disposition of any Collateral or security, to any Indebtedness whatsoever owing from such person or secured by such Collateral or security, in such manner and order as the Agent determines in its sole discretion, and regardless of whether such Indebtedness is part of the Secured Obligations, is secured, or is due and payable. Each Borrower consents and agrees that the Agent shall be under no obligation to marshal any assets in favor of Borrower, or against or in payment of any or all of the Secured Obligations. Each Borrower further consents and agrees that the Agent shall have no duties or responsibilities whatsoever with respect to any property securing any or all of the Secured Obligations. Without limiting the generality of the foregoing, the Agent shall have no obligation to monitor, verify, audit, examine, or obtain or maintain any insurance with respect to, any property securing any or all of the Secured Obligations.

(d) Independent Liability. Each Borrower hereby agrees that one or more successive or concurrent actions may be brought hereon against such Borrower, in the same action in which any other Borrower may be sued or in separate actions, as often as deemed advisable by Agent. Each Borrower is fully aware of the financial condition of each other Borrower and is executing and delivering this Agreement based solely upon its own independent investigation of all matters pertinent hereto, and such Borrower is not relying in any manner upon any representation or statement of the Agent or any Lender with respect thereto. Each Borrower represents and warrants that it is in a position to obtain, and each Borrower hereby assumes full responsibility for obtaining, any additional information concerning any other Borrower's financial condition and any other matter pertinent hereto as such Borrower may desire, and such Borrower is not relying upon or expecting the Agent to furnish to it any information now or hereafter in the Agent's possession concerning the same or any other matter.

(e) Subordination. All Indebtedness of a Borrower now or hereafter arising held by another Borrower is subordinated to the Secured Obligations and the Borrower holding the Indebtedness shall take all actions reasonably requested by Agent to effect, to enforce and to give notice of such subordination.

11.20 Amendment and Restatement. This Agreement amends and restates in its entirety the Original A&R LSA effective as of the date hereof. Anything contained herein to the contrary notwithstanding, this Agreement is not intended to and shall not serve to effect a novation of the "Secured Obligations" (as defined in the Original A&R LSA). Instead, it is the express intention of the parties hereto to reaffirm the indebtedness, obligations and liabilities created under the Original A&R LSA which is secured by the Collateral pursuant to the terms of the applicable Loan Documents. Borrower ratifies, affirms and confirms that the liens and security interests granted pursuant to the applicable Loan Documents, including without limitation the Pledge Agreements, secure the applicable indebtedness, liabilities and obligations of Borrower to Agent and the Lenders under the Original A&R LSA, as amended and restated by this Agreement, the Loan Documents shall continue in full force and effect in accordance with their terms unless otherwise amended by the parties thereto, and that the term "Secured Obligations" as used

in the Loan Documents (or any other term used therein to describe or refer to the indebtedness, liabilities and obligations of Borrower to Agent and the Lenders) includes, without limitation, the indebtedness, liabilities and obligations of Borrower under this Agreement, and under the Original A&R LSA, as amended and restated hereby, as the same further may be amended, modified, supplemented and/or restated from time to time and Borrower assumes all such Secured Obligations. Pursuant to the definition of Borrower in this Agreement, the security interests granted pursuant to Section 3.1 and by the Pledge Agreements are granted by the Company and each other Person constituting the Borrower in the Company's and each such Person's respective right, title and interest in and to any and all presently existing and hereafter created or acquired Collateral. The Loan Documents and all agreements, instruments and documents executed or delivered in connection with any of the foregoing shall each be deemed to be amended to the extent necessary to give effect to the provisions of this Agreement. Each reference to the "Loan and Security Agreement" in any Loan Document shall mean and be a reference to this Agreement (as further amended, restated, supplemented or otherwise modified from time to time). Cross-references in the Loan Documents to particular section numbers in the Original A&R LSA shall be deemed to be cross-references to the corresponding sections, as applicable, of this Agreement.

11.21 Participations. Each Lender that sells a participation shall, acting solely for this purpose as a non-fiduciary agent of the Borrower, maintain a register on which it enters the name and address of each participant and the principal amounts (and stated interest) of each participant's interest in the Loans or other obligations under the Loan Documents (the "Participant Register"); provided that no Lender shall have any obligation to disclose all or any portion of the Participant Register (including the identity of any participant or any information relating to a participant's interest in any commitments, loans, its other obligations under any Loan Document) to any Person except to the extent that such disclosure is necessary to establish that such commitment, loan, letter of credit or other obligation is in registered form under Section 5f.103-1(c) of the United States Treasury Regulations. The entries in the Participant Register shall be conclusive absent manifest error, and such Lender shall treat each Person whose name is recorded in the Participant Register as the owner of such participation for all purposes of this Agreement notwithstanding any notice to the contrary. For the avoidance of doubt, the Agent (in its capacity as Agent) shall have no responsibility for maintaining a Participant Register.

11.22 Electronic Execution of Certain Other Documents. The words "execution," "execute", "signed," "signature," and words of like import in or related to any document to be signed in connection with this Agreement and the transactions contemplated hereby (including without limitation assignments, assumptions, amendments, waivers and consents) shall be deemed to include electronic signatures, the electronic matching of assignment terms and contract formations on electronic platforms approved by the Agent, or the keeping of records in electronic form, each of which shall be of the same legal effect, validity or enforceability as a manually executed signature or the use of a paper-based recordkeeping system, as the case may be, to the extent and as provided for in any applicable law, including the Federal Electronic Signatures in Global and National

Commerce Act, the California Uniform Electronic Transaction Act, or any other similar state laws based on the Uniform Electronic Transactions Act.

(SIGNATURES TO FOLLOW)

IN WITNESS WHEREOF, Borrower, Agent and Lender have duly executed and delivered this Second Amended and Restated Loan and Security Agreement as of the day and year first above written.

BORROWER:

X4 PHARMACEUTICALS, INC. (F/K/A
ARSANIS, INC.)

Signature: /s/ Adam Mostafa
Print Name: Adam Mostafa
Title: Chief Financial Officer

X4 THERAPEUTICS, INC. (F/K/A
X4 PHARMACEUTICALS, INC.)

Signature: /s/ Adam Mostafa
Print Name: Adam Mostafa
Title: Chief Financial Officer

Accepted in Palo Alto, California:

AGENT:

HERCULES CAPITAL, INC.

Signature: /s/Jennifer Choe
Print Name: Jennifer Choe
Title: Associate General Counsel

LENDERS:

HERCULES CAPITAL, INC.

Signature: /s/Jennifer Choe
Print Name: Jennifer Choe
Title: Associate General Counsel

HERCULES FUNDING IV LLC

Signature: /s/Jennifer Choe
Print Name: Jennifer Choe
Title: Authorized Signatory

HERCULES CAPITAL FUNDING TRUST
2022-1

Signature: /s/Jennifer Choe
Print Name: Jennifer Choe
Title: Authorized Signatory

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ADDENDUM 1 to
SECOND AMENDED AND RESTATED LOAN AND SECURITY AGREEMENT

TAXES; INCREASED COSTS

1. **Defined Terms.** For purposes of this Addendum 1:

a. **“Connection Income Taxes”** means Other Connection Taxes that are imposed on or measured by net income (however denominated) or that are franchise Taxes or branch profits Taxes.

b. **“Excluded Taxes”** means any of the following Taxes imposed on or with respect to a Recipient or required to be withheld or deducted from a payment to a Recipient, (i) Taxes imposed on or measured by net income (however denominated), franchise Taxes, and branch profits Taxes, in each case, (A) imposed as a result of such Recipient being organized under the laws of, or having its principal office or, in the case of any Lender, its applicable lending office located in, the jurisdiction imposing such Tax (or any political subdivision thereof) or (B) that are Other Connection Taxes, (ii) in the case of a Lender, U.S. federal withholding Taxes imposed on amounts payable to or for the account of such Lender with respect to an applicable interest in a Loan or Term Commitment pursuant to a law in effect on the date on which (A) such Lender acquires such interest in the Loan or Term Commitment or (B) such Lender changes its lending office, except in each case to the extent that, pursuant to Section 2 or Section 4 of this Addendum 1, amounts with respect to such Taxes were payable either to such Lender’s assignor immediately before such Lender became a party hereto or to such Lender immediately before it changed its lending office, (iii) Taxes attributable to such Recipient’s failure to comply with Section 7 of this Addendum 1 and (iv) any withholding Taxes imposed under FATCA.

c. **“FATCA”** means Sections 1471 through 1474 of the Code, as of the date of this Agreement (or any amended or successor version that is substantively comparable and not materially more onerous to comply with), any current or future regulations or official interpretations thereof, any agreements entered into pursuant to Section 1471(b)(1) of the Code, and any fiscal or regulatory legislation, rules or practices adopted pursuant to any intergovernmental agreement, treaty or convention among governmental authorities and implementing such Sections of the Code.

d. **“Foreign Lender”** means a Lender that is not a U.S. Person.

e. **“Indemnified Taxes”** means (i) Taxes, other than Excluded Taxes, imposed on or with respect to any payment made by or on account of any obligation of the Borrower under any Loan Document and (ii) to the extent not otherwise described in clause (i), Other Taxes.

f. **“Other Connection Taxes”** means, with respect to any Recipient, Taxes imposed as a result of a present or former connection between such Recipient and the jurisdiction imposing such Tax (other than connections arising from such Recipient having executed, delivered, become a party to, performed its obligations under, received payments under, received or perfected a security interest under, engaged in any other transaction pursuant to or enforced any Loan Document, or sold or assigned an interest in any Loan or Loan Document).

g. **“Other Taxes”** means all present or future stamp, court or documentary, intangible, recording, filing or similar Taxes that arise from any payment made under, from the execution, delivery, performance, enforcement or registration of, from the receipt or perfection of a security interest under, or otherwise with respect to, any Loan Document, except any such Taxes that are Other Connection Taxes imposed with respect to an assignment.

h. **“Recipient”** means the Agent or any Lender, as applicable.

i. **“Taxes”** means all present or future taxes, levies, imposts, duties, deductions, withholdings (including backup withholding), assessments, fees or other charges imposed by any governmental authority, including any interest, additions to tax or penalties applicable thereto.

j. **“Withholding Agent”** means the Borrower and the Agent.

2. **Payments Free of Taxes.** Any and all payments by or on account of any obligation of the Borrower under any Loan Document shall be made without deduction or withholding for any Taxes, except as required by applicable law. If any applicable law (as determined in the good faith discretion of an applicable Withholding Agent) requires the deduction or withholding of any Tax from any such payment by a Withholding Agent, then the applicable Withholding Agent shall be entitled to make such deduction or withholding and shall timely pay the full amount deducted or withheld to the relevant governmental authority in accordance with applicable law and, if such Tax is an Indemnified Tax, then the sum payable by the Borrower shall be increased as necessary so that after such deduction or withholding has been made (including such deductions and withholdings applicable to additional sums payable under this Section 2 or Section 4 of this Addendum 1) the applicable Recipient receives an amount equal to the sum it would have received had no such deduction or withholding been made.

3. **Payment of Other Taxes by Borrower.** The Borrower shall timely pay to the relevant governmental authority in

accordance with applicable law, or at the option of the Agent timely reimburse it for the payment of, any Other Taxes.

4. **Indemnification by Borrower.** The Borrower shall indemnify each Recipient, within 10 days after demand therefor, for the full amount of any Indemnified Taxes (including Indemnified Taxes imposed or asserted on or attributable to amounts payable under Section 2 of this Addendum 1 or this Section 4) payable or paid by such Recipient or required to be withheld or deducted from a payment to such Recipient and any reasonable expenses arising therefrom or with respect thereto, whether or not such Indemnified Taxes were correctly or legally imposed or asserted by the relevant governmental authority. A certificate as to the amount of such payment or liability delivered to the Borrower by a Lender (with a copy to the Agent), or by the Agent on its own behalf or on behalf of a Lender, shall be conclusive absent manifest error. In addition, the Borrower agrees to pay, and to save the Agent and any Lender harmless from, any and all liabilities with respect to, or resulting from any delay in paying, any and all excise, sales or other similar taxes (excluding taxes imposed on or measured by the net income of the Agent or such Lender) that may be payable or determined to be payable with respect to any of the Collateral or this Agreement.

5. **Indemnification by the Lenders.** Each Lender shall severally indemnify the Agent, within 10 days after demand therefor, for (a) any Indemnified Taxes attributable to such Lender (but only to the extent that the Borrower has not already indemnified the Agent for such Indemnified Taxes and without limiting the obligation of the Borrower to do so), (b) any Taxes attributable to such Lender's failure to comply with the provisions of Section 11.21 of the Agreement relating to the maintenance of a Participant Register and (c) any Excluded Taxes attributable to such Lender, in each case, that are payable or paid by the Agent in connection with any Loan Document, and any reasonable expenses arising therefrom or with respect thereto, whether or not such Taxes were correctly or legally imposed or asserted by the relevant governmental authority. A certificate as to the amount of such payment or liability delivered to any Lender by the Agent shall be conclusive absent manifest error. Each Lender hereby authorizes the Agent to set off and apply any and all amounts at any time owing to such Lender under any Loan Document or otherwise payable by the Agent to the Lender from any other source against any amount due to the Agent under this Section 5.

6. **Evidence of Payments.** As soon as practicable after any payment of Taxes by the Borrower to a governmental authority

pursuant to the provisions of this Addendum 1, the Borrower shall deliver to the Agent the original or a certified copy of a receipt issued by such governmental authority evidencing such payment, a copy of the return reporting such payment or other evidence of such payment reasonably satisfactory to the Agent.

7. Status of Lenders.

a. Any Lender that is entitled to an exemption from or reduction of withholding Tax with respect to payments made under any Loan Document shall deliver to the Borrower and the Agent, at the time or times reasonably requested by the Borrower or the Agent, such properly completed and executed documentation reasonably requested by the Borrower or the Agent as will permit such payments to be made without withholding or at a reduced rate of withholding. In addition, any Lender, if reasonably requested by the Borrower or the Agent, shall deliver such other documentation prescribed by applicable law or reasonably requested by the Borrower or the Agent as will enable the Borrower or the Agent to determine whether or not such Lender is subject to backup withholding or information reporting requirements. Notwithstanding anything to the contrary in the preceding two sentences, the completion, execution and submission of such documentation (other than such documentation set forth in Sections 7(b)(i), 7(b)(ii) and 7(b)(iv) of this Addendum 1) shall not be required if in the Lender's reasonable judgment such completion, execution or submission would subject such Lender to any material unreimbursed cost or expense or would materially prejudice the legal or commercial position of such Lender.

b. Without limiting the generality of the foregoing, in the event that the Borrower is a U.S. Person,

i. any Lender that is a U.S. Person shall deliver to the Borrower and the Agent on or prior to the date on which such Lender becomes a Lender under this Agreement (and from time to time thereafter upon the reasonable request of the Borrower or the Agent), executed copies of IRS Form W-9 certifying that such Lender is exempt from U.S. federal backup withholding tax;

ii. any Foreign Lender shall, to the extent it is legally entitled to do so, deliver to the Borrower and the Agent (in such number of copies as shall be requested by the recipient) on or prior to the date on which such Foreign Lender becomes a Lender under this Agreement (and from time to time thereafter upon the reasonable request of the Borrower or the Agent), whichever of the following is applicable:

A. in the case of a Foreign Lender claiming the benefits of an income tax treaty to which the United States is a party (x) with respect to payments of interest under any Loan Document, executed copies of IRS Form W-8BEN or IRS Form W-8BEN-E establishing an exemption from, or reduction of, U.S. federal withholding Tax pursuant to the "interest" article of such tax treaty and (y) with respect to any other applicable payments under any Loan Document, IRS Form W-

8BEN or IRS Form W-8BEN-E establishing an exemption from, or reduction of, U.S. federal withholding Tax pursuant to the “business profits” or “other income” article of such tax treaty;

B. executed copies of IRS Form W-8ECI;

C. in the case of a Foreign Lender claiming the benefits of the exemption for portfolio interest under Section 881(c) of the Code, (x) a certificate substantially in the form of Exhibit I-1 to the effect that such Foreign Lender is not a “bank” within the meaning of Section 881(c)(3)(A) of the Code, a “10 percent shareholder” of the Borrower within the meaning of Section 871(h)(3)(B) of the Code, or a “controlled foreign corporation” related to the Borrower as described in Section 881(c)(3)(C) of the Code (a “**U.S. Tax Compliance Certificate**”) and (y) executed copies of IRS Form W-8BEN or IRS Form W-8BEN-E; or

D. to the extent a Foreign Lender is not the beneficial owner, executed copies of IRS Form W-8IMY, accompanied by IRS Form W-8ECI, IRS Form W-8BEN, IRS Form W-8BEN-E, a U.S. Tax Compliance Certificate substantially in the form of Exhibit I-2 or Exhibit I-3, IRS Form W-9, and/or other certification documents from each beneficial owner, as applicable; provided that if the Foreign Lender is a partnership and one or more direct or indirect partners of such Foreign Lender are claiming the portfolio interest exemption, such Foreign Lender may provide a U.S. Tax Compliance Certificate substantially in the form of Exhibit I-4 on behalf of each such direct and indirect partner;

iii. any Foreign Lender shall, to the extent it is legally entitled to do so, deliver to the Borrower and the Agent (in such number of copies as shall be requested by the recipient) on or prior to the date on which such Foreign Lender becomes a Lender under this Agreement (and from time to time thereafter upon the reasonable request of the Borrower or the Agent), executed copies of any other form prescribed by applicable law as a basis for claiming exemption from or a reduction in U.S. federal withholding Tax, duly completed, together with such supplementary documentation as may be prescribed by applicable law to permit the Borrower or the Agent to determine the withholding or deduction required to be made; and

iv. if a payment made to a Lender under any Loan Document would be subject to U.S. federal withholding Tax imposed by FATCA if such Lender were to fail to comply with the applicable reporting requirements of FATCA (including those contained in Section 1471(b) or 1472(b) of the Code, as applicable), such Lender shall deliver to the Borrower and the Agent at the time or times prescribed by law and at such time or times reasonably requested by the Borrower or the Agent such documentation prescribed by applicable law (including as prescribed by Section 1471(b)(3)(C)(i) of the Code) and such additional documentation reasonably requested by the Borrower or the Agent as may be necessary for the Borrower and the Agent to comply with their obligations under FATCA and to determine that such Lender has complied with such Lender’s obligations under FATCA or to determine the amount, if any, to deduct and withhold from such payment.

Solely for purposes of this clause (iv), "FATCA" shall include any amendments made to FATCA after the date of this Agreement.

c. Each Lender agrees that if any form or certification it previously delivered expires or becomes obsolete or inaccurate in any respect, it shall update such form or certification or promptly notify the Borrower and the Agent in writing of its legal inability to do so.

8. **Treatment of Certain Refunds.** If any party determines, in its sole discretion exercised in good faith, that it has received a refund of any Taxes as to which it has been indemnified pursuant to the provisions of this Addendum 1 (including by the payment of additional amounts pursuant to the provisions of this Addendum 1), it shall pay to the indemnifying party an amount equal to such refund (but only to the extent of indemnity payments made under the provisions of this Addendum 1 with respect to the Taxes giving rise to such refund), net of all out-of-pocket expenses (including Taxes) of such indemnified party and without interest (other than any interest paid by the relevant governmental authority with respect to such refund). Such indemnifying party, upon the request of such indemnified party, shall repay to such indemnified party the amount paid over pursuant to this Section 8 (plus any penalties, interest or other charges imposed by the relevant governmental authority) in the event that such indemnified party is required to repay such refund to such governmental authority.

Notwithstanding anything to the contrary in this Section 8, in no event will the indemnified party be required to pay any amount to an indemnifying party pursuant to this Section 8 the payment of which would place the indemnified party in a less favorable net after-Tax position than the indemnified party would have been in if the Tax subject to indemnification and giving rise to such refund had not been deducted, withheld or otherwise imposed and the indemnification payments or additional amounts with respect to such Tax had never been paid. This Section 8 shall not be construed to require any indemnified party to make available its Tax returns (or any other information relating to its Taxes that it deems confidential) to the indemnifying party or any other Person.

9. **Increased Costs.** If any change in applicable law shall subject any Recipient to any Taxes (other than (A) Indemnified Taxes, (B) Taxes described in clauses (ii) through (iv) of the definition of Excluded Taxes and (C) Connection Income Taxes) on its loans, loan principal, commitments, or other obligations, or its deposits, reserves, other liabilities or capital attributable thereto, and the result shall be to increase the cost to such Recipient of making, converting to, continuing or maintaining any Term Loan or

of maintaining its obligation to make any such Loan, or to reduce the amount of any sum received or receivable by such Recipient (whether of principal, interest or any other amount), then, upon the request of such Recipient, the Borrower will pay to such Recipient such additional amount or amounts as will compensate such Recipient for such additional costs incurred or reduction suffered.

10. **Survival.** Each party's obligations under the provisions of this Addendum 1 shall survive the resignation or replacement of the Agent or any assignment of rights by, or the replacement of, a Lender, the termination of the Term Commitments and the repayment, satisfaction or discharge of all obligations under any Loan Document.

EXHIBIT A
ADVANCE REQUEST

To: Agent: _____ Date: _____

Hercules Capital, Inc. (the "Agent")
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301
email:
Attn:

X4 Pharmaceuticals, Inc. ("Borrower") hereby requests from Hercules Capital, Inc. ("Lender") an Advance in the amount of _____ Dollars (\$_____) on _____, _____ (the "Advance Date") pursuant to the Second Amended and Restated Loan and Security Agreement among Borrower, Agent and Lender (the "Agreement"). Capitalized words and other terms used but not otherwise defined herein are used with the same meanings as defined in the Agreement.

Please:

(a) Issue a check payable to Borrower _____

or

(b) Wire Funds to Borrower's account _____

Bank: _____

Address: _____

ABA Number: _____

Account Number: _____

Account Name: _____

Contact Person: _____

Phone Number _____

To Verify Wire Info: _____

Email address: _____

Borrower represents that the conditions precedent to the Advance set forth in the Agreement are satisfied and shall be satisfied upon the making of such Advance, including but not limited to: (i) that no event that has had or could reasonably be expected to have a Material Adverse Effect has occurred and is continuing; (ii) that the representations and warranties set forth in the Agreement are and shall be true and correct in all material respects on and as of the

Advance Date with the same effect as though made on and as of such date, except to the extent such representations and warranties expressly relate to an earlier date; (iii) that Borrower is in compliance with all the terms and provisions set forth in each Loan Document on its part to be observed or performed; and (iv) that as of the Advance Date, no fact or condition exists that could (or could, with the passage of time, the giving of notice, or both) constitute an Event of Default under the Loan Documents. Borrower understands and acknowledges that Agent has the right to review the financial information supporting this representation and, based upon such review in its sole discretion, Lender may decline to fund the requested Advance.

Borrower hereby represents that Borrower's corporate status and locations have not changed since the date of the Agreement or, if the Attachment to this Advance Request is completed, are as set forth in the Attachment to this Advance Request.

Borrower agrees to notify Agent promptly before the funding of the Loan if any of the matters which have been represented above shall not be true and correct on the Borrowing Date and if Agent has received no such notice before the Advance Date then the statements set forth above shall be deemed to have been made and shall be deemed to be true and correct as of the Advance Date.

Executed as of [], 20[].

BORROWER: X4 PHARMACEUTICALS, INC.

SIGNATURE: _____

TITLE: _____

PRINT NAME: _____

ATTACHMENT TO ADVANCE REQUEST

Dated: January 6, 2023

Borrower hereby represents and warrants to Agent that the Company's current name and organizational status is as follows:

Name:	X4 Pharmaceuticals, Inc.
Type of organization:	Corporation
State of organization:	Delaware
Organization file number:	4851982

Borrower hereby represents and warrants to Agent that the street addresses, cities, states and postal codes of its current locations are as follows:

EXHIBIT B

SECURED TERM PROMISSORY NOTE

\$[] ,000,000

Advance Date: ____ __, 20[]

Maturity Date: _____ __, 20[]

FOR VALUE RECEIVED, X4 PHARMACEUTICALS, INC., a Delaware corporation, for itself and each of its Qualified Subsidiaries (the "Borrower") hereby promises to pay to the order of [Hercules Capital, Inc., a Maryland corporation], or the holder of this Note (the "Lender") at 400 Hamilton Avenue, Suite 310, Palo Alto, CA 94301 or such other place of payment as the holder of this Secured Term Promissory Note (this "Promissory Note") may specify from time to time in writing, in lawful money of the United States of America, the principal amount of [] Million Dollars (\$[] ,000,000) or such other principal amount as Lender has advanced to Borrower, together with interest at a rate as set forth in Section 2.2(c) of the Loan Agreement based upon a year consisting of 360 days, with interest computed daily based on the actual number of days in each month.

This Promissory Note is the Note referred to in, and is executed and delivered in connection with, that certain Second Amended and Restated Loan and Security Agreement dated January 6, 2023, by and among Borrower, Hercules Capital, Inc., a Maryland corporation (the "Agent") and the several banks and other financial institutions or entities from time to time party thereto as lender (as the same may from time to time be amended, modified or supplemented in accordance with its terms, the "Loan Agreement"), and is entitled to the benefit and security of the Loan Agreement and the other Loan Documents (as defined in the Loan Agreement), to which reference is made for a statement of all of the terms and conditions thereof. All payments shall be made in accordance with the Loan Agreement. All terms defined in the Loan Agreement shall have the same definitions when used herein, unless otherwise defined herein. An Event of Default under the Loan Agreement shall constitute a default under this Promissory Note.

Borrower waives presentment and demand for payment, notice of dishonor, protest and notice of protest under the UCC or any applicable law. Borrower agrees to make all payments under this Promissory Note without setoff, recoupment or deduction and regardless of any counterclaim or defense. This Promissory Note has been negotiated and delivered to Lender and is payable in the State of California. This Promissory Note shall be governed by and construed and enforced in accordance with, the laws of the State of California, excluding any conflicts of law rules or principles that would cause the application of the laws of any other jurisdiction.

BORROWER FOR ITSELF AND

ON BEHALF OF ITS QUALIFIED SUBSIDIARIES:

X4 PHARMACEUTICALS, INC.

By: _____

Title: _____

EXHIBIT C

NAME, LOCATIONS, AND OTHER INFORMATION FOR BORROWER

1. Borrower represents and warrants to Agent that

(a) the Company's current name and organizational status as of the Closing Date is as follows:

Name: X4 Pharmaceuticals, Inc.

Type of organization: Corporation

State of organization: Delaware

Organization file number: 4851982

(b) Therapeutics' current name and organizational status as of the Closing Date is as follows:

Name: X4 Therapeutics, Inc.

Type of organization: Corporation

State of organization: Delaware

Organization file number: 5568691

2. Borrower represents and warrants to Agent that for five (5) years prior to the Closing Date, Borrower did not do business under any other name or organization or form except the following:

Name:

Used during dates of:

Type of Organization:

State of organization:

Organization file Number:

Borrower's fiscal year ends on _____

Borrower's federal employer tax identification number is: _____

3. Borrower represents and warrants to Agent that its chief executive office is located at

_____.

EXHIBIT D

BORROWER'S PATENTS, TRADEMARKS, COPYRIGHTS AND LICENSES

[***]

EXHIBIT E

BORROWER'S DEPOSIT ACCOUNTS AND INVESTMENT ACCOUNTS

[***]

EXHIBIT F
COMPLIANCE CERTIFICATE

Hercules Capital, Inc. (as “Agent”)
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301

Reference is made to that certain Second Amended and Restated Loan and Security Agreement dated January 6, 2023 and the Loan Documents (as defined therein) entered into in connection with such Second Amended and Restated Loan and Security Agreement all as may be amended from time to time (hereinafter referred to collectively as the “Loan Agreement”) by and among Hercules Capital, Inc. (the “Agent”), the several banks and other financial institutions or entities from time to time party thereto (collectively, the “Lender”) and Hercules Capital, Inc., as agent for the Lender (the “Agent”) and X4 Pharmaceuticals, Inc. (the “Company”) as Borrower. All capitalized terms not defined herein shall have the same meaning as defined in the Loan Agreement.

The undersigned is an Officer of the Company, knowledgeable of all Company financial matters, and is authorized to provide certification of information regarding the Company; hereby certifies, in such capacity, that in accordance with the terms and conditions of the Loan Agreement, the Company is in compliance for the period ending _____ of all covenants, conditions and terms and hereby reaffirms that all representations and warranties contained therein are true and correct on and as of the date of this Compliance Certificate with the same effect as though made on and as of such date, except to the extent such representations and warranties expressly relate to an earlier date, after giving effect in all cases to any standard(s) of materiality contained in the Loan Agreement as to such representations and warranties. Attached are the required documents supporting the above certification. The undersigned further certifies that these are prepared in accordance with GAAP (except for the absence of footnotes with respect to unaudited financial statement and subject to normal year end adjustments) and are consistent from one period to the next except as explained below.

REPORTING REQUIREMENT	REQUIRED	CHECK IF ATTACHED
Interim Financial Statements	Monthly within 30 days	
Interim Financial Statements	Quarterly within 45 days (for first 3 calendar quarters)	
Audited Financial Statements	FYE within 90 days	
Budget and forecast	At least annually within 60 days following FYE	

7.12 DEPOSIT ACCOUNTS

(A) Are all Cash balances held by Borrower held in accounts subject to an Account Control Agreement, other than Excluded Accounts? Yes No

(B) Is the Cash held by the Excluded Subsidiary less than \$5,000,000? Yes No

7.21 MINIMUM CASH

(A)1 [Prior to Borrower's achievement of the Approval Milestone] Are aggregate Qualified Cash balances held by Borrower (excluding Security Corporation Subsidiary and the Excluded Subsidiary) in accounts subject to an Account Control Agreement in an amount greater than or equal to \$20,000,000? Yes No

(A)2 [Following Borrower's achievement of the Approval Milestone] Are aggregate Qualified Cash balances held by Borrower (excluding Security Corporation Subsidiary and the Excluded Subsidiary) held in accounts subject to an Account Control Agreement in an amount greater than or equal \$10,000,000? Yes No

(B) If No, is Security Corporation Subsidiary holding any Cash? Yes No

(C) If No, is the Excluded Subsidiary holding more than \$5,000,000 in Cash?
 Yes No

The undersigned hereby also confirms the below disclosed accounts represent all depository accounts and securities accounts presently open in the name of each Borrower or Borrower Subsidiary/Affiliate, as applicable.

Each new account that has been opened since delivery of the previous Compliance Certificate is designated below with a "*".

		Depository AC #	Financial Institution	Account Type (Depository / Securities)	Last Month Ending Account Balance	Purpose of Account
BORROWER Name/Address:						
	1					
	2					

	3					
	4					
	5					
	6					
	7					
BORROWER SUSIDIARY / AFFILIATE COMPANY Name/Address						
	1					
	2					
	3					
	4					
	5					
	6					
	7					

7.22 PERFORMANCE COVENANT [*Commencing January 31, 2025, and thereafter*]

(A) Is Borrower’s T6M Net Product Revenue, tested monthly, equal to or greater than 55% of the Net Product Revenue Forecast?

Yes No

(B) If No, does either

- (i) Borrower maintain Qualified Cash in an amount equal to or greater than 80% of the aggregate principal amount of Term Loan Advances outstanding under this Agreement,
- or

(ii) both Company maintain a market capitalization of at least \$500,000,000 and also Borrower maintain Qualified Cash in an amount equal to at least 50% of the aggregate principal amount of Term Loan Advances outstanding under this Agreement?

Yes No

7.23 SECURITY CORPORATION INVESTMENT CONDITIONS

(A) Does the Security Corporation Subsidiary have any assets or liabilities?

Yes No

(B) If yes, is the Security Corporation Subsidiary in compliance with the Security Corporation Investment Conditions? Yes No

(B) If No, Is Borrower required to maintain minimum cash under Section 7.21(a)?

Yes No

Very Truly Yours,

X4 PHARMACEUTICALS, INC.

By: _____

Name: _____

Its: _____

EXHIBIT G

FORM OF JOINDER AGREEMENT

This Joinder Agreement (the “Joinder Agreement”) is made and dated as of [], 20[], and is entered into by and between _____, a _____ corporation (“Subsidiary”), and HERCULES CAPITAL, INC., a Maryland corporation (as “Agent”).

RECITALS

A. Subsidiary’s Affiliate, X4 Pharmaceuticals, Inc. (“Company”) has entered into that certain Second Amended and Restated Loan and Security Agreement dated as of January 6, 2023, with the several banks and other financial institutions or entities from time to time party thereto as lender (collectively, the “Lender”) and the Agent, as such agreement may be amended (the “Loan Agreement”), together with the other agreements executed and delivered in connection therewith;

B. Subsidiary acknowledges and agrees that it will benefit both directly and indirectly from Company’s execution of the Loan Agreement and the other agreements executed and delivered in connection therewith;

AGREEMENT

NOW THEREFORE, Subsidiary and Agent agree as follows:

1. The recitals set forth above are incorporated into and made part of this Joinder Agreement. Capitalized terms not defined herein shall have the meaning provided in the Loan Agreement.
 2. By signing this Joinder Agreement, Subsidiary shall be bound by the terms and conditions of the Loan Agreement the same as if it were the Borrower (as defined in the Loan Agreement) under the Loan Agreement, mutatis mutandis, provided however, that (a) with respect to (i) Section 5.1 of the Loan Agreement, Subsidiary represents that it is an entity duly organized, legally existing and in good standing under the laws of [], (b) neither Agent nor Lender shall have any duties, responsibilities or obligations to Subsidiary arising under or related to the Loan Agreement or the other Loan Documents, (c) that if Subsidiary is covered by Company’s insurance, Subsidiary shall not be required to maintain separate insurance or comply with the provisions of Sections 6.1 and 6.2 of the Loan Agreement, and (d) that as long as Company satisfies the requirements of Section 7.1 of the Loan Agreement, Subsidiary shall not have to provide Agent separate Financial Statements. To the extent that Agent or Lender has any duties, responsibilities or obligations arising under or related to the Loan Agreement or the other Loan Documents, those duties, responsibilities or obligations shall flow only to Company and not to Subsidiary or any other Person or entity. By way of example (and not an exclusive list): (i) Agent’s providing notice to Company in accordance with the Loan Agreement or as otherwise agreed among Company, Agent and Lender shall be deemed provided to Subsidiary; (ii) a Lender’s providing an Advance to Company shall be deemed an Advance to Subsidiary; and (iii) Subsidiary shall have no right to request an Advance or make any other demand on Lender.
-

3. Subsidiary agrees not to certificate its equity securities without Agent's prior written consent, which consent may be conditioned on the delivery of such equity securities to Agent in order to perfect Agent's security interest in such equity securities.
4. Subsidiary acknowledges that it benefits, both directly and indirectly, from the Loan Agreement, and hereby waives, for itself and on behalf on any and all successors in interest (including without limitation any assignee for the benefit of creditors, receiver, bankruptcy trustee or itself as debtor-in-possession under any bankruptcy proceeding) to the fullest extent provided by law, any and all claims, rights or defenses to the enforcement of this Joinder Agreement on the basis that (a) it failed to receive adequate consideration for the execution and delivery of this Joinder Agreement or (b) its obligations under this Joinder Agreement are avoidable as a fraudulent conveyance.
5. As security for the prompt, complete payment when due (whether on the payment dates or otherwise) of all the Secured Obligations, Subsidiary grants to Agent a security interest in all of Subsidiary's right, title, and interest in and to the Collateral.

[REMAINDER OF PAGE INTENTIONALLY LEFT BLANK]

[SIGNATURE PAGE TO JOINDER AGREEMENT]

SUBSIDIARY:

_____.

By:

Name:

Title:

Address:

Telephone: _____

email: _____

AGENT:

HERCULES CAPITAL, INC.

By: _____

Name: _____

Title: _____

Address:

400 Hamilton Ave., Suite 310

Palo Alto, CA 94301

email:

Telephone:

EXHIBIT H

ACH DEBIT AUTHORIZATION AGREEMENT

Hercules Capital, Inc.
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301

Re: Second Amended and Restated Loan and Security Agreement dated January 6, 2023 (the "Agreement") by and among X4 Pharmaceuticals, Inc. ("Borrower") and Hercules Capital, Inc., as agent ("Company") and the lenders party thereto (collectively, the "Lender")

In connection with the above referenced Agreement, the Borrower hereby authorizes the Company to initiate debit entries for (i) the periodic payments due under the Agreement and (ii) out-of-pocket legal fees and costs incurred by Agent or Lender pursuant to Section 11.11 of the Agreement to the Borrower's account indicated below. The Borrower authorizes the depository institution named below to debit to such account.

DEPOSITORY NAME	BRANCH
CITY	STATE AND ZIP CODE
TRANSIT/ABA NUMBER	ACCOUNT NUMBER

This authority will remain in full force and effect so long as any amounts are due under the Agreement.

[signature page follows]

[signature page to ACH Debit Authorization Agreement]

X4 PHARMACEUTICALS, INC.

By: _____

Date: _____

EXHIBIT I-1

FORM OF U.S. TAX COMPLIANCE CERTIFICATE

(For Foreign Lenders That Are Not Partnerships For U.S. Federal Income Tax Purposes)

Reference is hereby made to that certain Second Amended and Restated Loan and Security Agreement dated as of January 6, 2023 (as amended, supplemented or otherwise modified from time to time, the "Loan Agreement") by and between X4 PHARMACEUTICALS, INC., a Delaware corporation, and each of its Subsidiaries (as defined in the Loan Agreement) (hereinafter collectively referred to as the "Borrower"), the several banks and other financial institutions or entities from time to time parties to the Loan Agreement (collectively, referred to as the "Lenders"), and HERCULES CAPITAL, INC., a Maryland corporation, in its capacity as administrative agent and collateral agent for itself and the Lenders (in such capacity, the "Agent").

Pursuant to the provisions of Addendum 1 of the Loan Agreement, the undersigned hereby certifies that (i) it is the sole record and beneficial owner of the Loan(s) (as well as any promissory note(s) evidencing such Loan(s)) in respect of which it is providing this certificate, (ii) it is not a "bank" within the meaning of Section 881(c)(3)(A) of the Code, (iii) it is not a "ten percent shareholder" of the Borrower within the meaning of Section 871(h)(3)(B) of the Code and (iv) it is not a "controlled foreign corporation" related to the Borrower as described in Section 881(c)(3)(C) of the Code.

The undersigned has furnished the Agent and the Borrower with a certificate of its non-U.S. Person status on IRS Form W-8BEN or IRS Form W-8BEN-E. By executing this certificate, the undersigned agrees that (1) if the information provided in this certificate changes, the undersigned shall promptly so inform the Borrower and the Agent, and (2) the undersigned shall have at all times furnished the Borrower and the Agent with a properly completed and currently effective certificate in either the calendar year in which (and in any event before) each payment is to be made to the undersigned, or in either of the two calendar years preceding such payments.

Unless otherwise defined herein, terms defined in the Loan Agreement and used herein shall have the meanings given to them in the Loan Agreement.

Date: _____, 20__

[NAME OF LENDER]

By: _____

Name: _____

Title: _____

EXHIBIT I-2

FORM OF U.S. TAX COMPLIANCE CERTIFICATE

(For Foreign Participants That Are Not Partnerships For U.S. Federal Income Tax Purposes)

Reference is hereby made to that certain Second Amended and Restated Loan and Security Agreement dated as of January 6, 2023 (as amended, supplemented or otherwise modified from time to time, the "Loan Agreement") by and between X4 PHARMACEUTICALS, INC., a Delaware corporation, and each of its Subsidiaries (as defined in the Loan Agreement) (hereinafter collectively referred to as the "Borrower"), the several banks and other financial institutions or entities from time to time parties to the Loan Agreement (collectively, referred to as the "Lenders"), and HERCULES CAPITAL, INC., a Maryland corporation, in its capacity as administrative agent and collateral agent for itself and the Lenders (in such capacity, the "Agent").

Pursuant to the provisions of Addendum 1 of the Loan Agreement, the undersigned hereby certifies that (i) it is the sole record and beneficial owner of the participation in respect of which it is providing this certificate, (ii) it is not a "bank" within the meaning of Section 881(c)(3)(A) of the Code, (iii) it is not a "ten percent shareholder" of the Borrower within the meaning of Section 871(h)(3)(B) of the Code and (iv) it is not a "controlled foreign corporation" related to the Borrower as described in Section 881(c)(3)(C) of the Code.

The undersigned has furnished its participating Lender with a certificate of its non-U.S. Person status on IRS Form W-8BEN or IRS Form W-8BEN-E. By executing this certificate, the undersigned agrees that (1) if the information provided in this certificate changes, the undersigned shall promptly so inform such Lender in writing, and (2) the undersigned shall have at all times furnished such Lender with a properly completed and currently effective certificate in either the calendar year in which (and in any event before) each payment is to be made to the undersigned, or in either of the two calendar years preceding such payments.

Unless otherwise defined herein, terms defined in the Loan Agreement and used herein shall have the meanings given to them in the Loan Agreement.

Date: _____, 20__

[NAME OF PARTICIPANT]

By: _____

Name: _____

Title: _____

EXHIBIT I-3

FORM OF U.S. TAX COMPLIANCE CERTIFICATE

(For Foreign Participants That Are Partnerships For U.S. Federal Income Tax Purposes)

Reference is hereby made to that certain Second Amended and Restated Loan and Security Agreement dated as of January 6, 2023 (as amended, supplemented or otherwise modified from time to time, the "Loan Agreement") by and between X4 PHARMACEUTICALS, INC., a Delaware corporation, and each of its Subsidiaries (as defined in the Loan Agreement) (hereinafter collectively referred to as the "Borrower"), the several banks and other financial institutions or entities from time to time parties to the Loan Agreement (collectively, referred to as the "Lenders"), and HERCULES CAPITAL, INC., a Maryland corporation, in its capacity as administrative agent and collateral agent for itself and the Lenders (in such capacity, the "Agent").

Pursuant to the provisions of Addendum 1 of the Loan Agreement, the undersigned hereby certifies that (i) it is the sole record owner of the participation in respect of which it is providing this certificate, (ii) its direct or indirect partners/members are the sole beneficial owners of such participation, (iii) with respect such participation, neither the undersigned nor any of its direct or indirect partners/members is a "bank" extending credit pursuant to a loan agreement entered into in the ordinary course of its trade or business within the meaning of Section 881(c)(3)(A) of the Code, (iv) none of its direct or indirect partners/members is a "ten percent shareholder" of the Borrower within the meaning of Section 871(h)(3)(B) of the Code and (v) none of its direct or indirect partners/members is a "controlled foreign corporation" related to the Borrower as described in Section 881(c)(3)(C) of the Code.

The undersigned has furnished its participating Lender with IRS Form W-8IMY accompanied by one of the following forms from each of its partners/members that is claiming the portfolio interest exemption: (i) an IRS Form W-8BEN or IRS Form W-8BEN-E or (ii) an IRS Form W-8IMY accompanied by an IRS Form W-8BEN or IRS Form W-8BEN-E from each of such partner's/member's beneficial owners that is claiming the portfolio interest exemption. By executing this certificate, the undersigned agrees that (1) if the information provided in this certificate changes, the undersigned shall promptly so inform such Lender and (2) the undersigned shall have at all times furnished such Lender with a properly completed and currently effective certificate in either the calendar year in which (and in any event before) each payment is to be made to the undersigned, or in either of the two calendar years preceding such payments.

Unless otherwise defined herein, terms defined in the Loan Agreement and used herein shall have the meanings given to them in the Loan Agreement.

Date: _____, 20__

[NAME OF PARTICIPANT]

By: _____

Name: _____

Title: _____

EXHIBIT I-4

FORM OF U.S. TAX COMPLIANCE CERTIFICATE

(For Foreign Lenders That Are Partnerships For U.S. Federal Income Tax Purposes)

Reference is hereby made to that certain Second Amended and Restated Loan and Security Agreement dated as of January 6, 2023 (as amended, supplemented or otherwise modified from time to time, the "Loan Agreement") by and between X4 PHARMACEUTICALS, INC., a Delaware corporation, and each of its Subsidiaries (as defined in the Loan Agreement) (hereinafter collectively referred to as the "Borrower"), the several banks and other financial institutions or entities from time to time parties to the Loan Agreement (collectively, referred to as the "Lenders"), and HERCULES CAPITAL, INC., a Maryland corporation, in its capacity as administrative agent and collateral agent for itself and the Lenders (in such capacity, the "Agent").

Pursuant to the provisions of Addendum 1 of the Loan Agreement, the undersigned hereby certifies that (i) it is the sole record owner of the Loan(s) (as well as any promissory note(s) evidencing such Loan(s)) in respect of which it is providing this certificate, (ii) its direct or indirect partners/members are the sole beneficial owners of such Loan(s) (as well as any promissory note(s) evidencing such Loan(s)), (iii) with respect to the extension of credit pursuant to this Loan Agreement or any other Loan Document, neither the undersigned nor any of its direct or indirect partners/members is a "bank" extending credit pursuant to a loan agreement entered into in the ordinary course of its trade or business within the meaning of Section 881(c)(3)(A) of the Code, (iv) none of its direct or indirect partners/members is a "ten percent shareholder" of the Borrower within the meaning of Section 871(h)(3)(B) of the Code and (v) none of its direct or indirect partners/members is a "controlled foreign corporation" related to the Borrower as described in Section 881(c)(3)(C) of the Code.

The undersigned has furnished the Agent and the Borrower with IRS Form W-8IMY accompanied by one of the following forms from each of its partners/members that is claiming the portfolio interest exemption: (i) an IRS Form W-8BEN or IRS Form W-8BEN-E or (ii) an IRS Form W-8IMY accompanied by an IRS Form W-8BEN or IRS Form W-8BEN-E from each of such partner's/member's beneficial owners that is claiming the portfolio interest exemption. By executing this certificate, the undersigned agrees that (1) if the information provided in this certificate changes, the undersigned shall promptly so inform the Borrower and the Agent, and (2) the undersigned shall have at all times furnished the Borrower and the Agent with a properly completed and currently effective certificate in either the calendar year in which (and in any event before) each payment is to be made to the undersigned, or in either of the two calendar years preceding such payments.

Unless otherwise defined herein, terms defined in the Loan Agreement and used herein shall have the meanings given to them in the Loan Agreement.

Date: _____, 20__

[NAME OF LENDER]

By: _____

Name: _____

Title: _____

**SCHEDULES TO
SECOND AMENDED AND RESTATED
LOAN AND SECURITY AGREEMENT**

dated as of January 6, 2023



SCHEDULE 1

SUBSIDIARIES

SCHEDULE 1.1

COMMITMENTS

[***]

SCHEDULE 1A

EXISTING PERMITTED INDEBTEDNESS

SCHEDULE 1B

EXISTING PERMITTED INVESTMENTS

SCHEDULE 1C

EXISTING PERMITTED LIENS

SCHEDULE 3.2

EXCLUDED COLLATERAL (SANOFI)

[***]

SCHEDULE 5.3

CONSENTS, ETC.

[***]

SCHEDULE 5.8

TAX MATTERS

[***]

SCHEDULE 5.9

INTELLECTUAL PROPERTY CLAIMS

SCHEDULE 5.10

INTELLECTUAL PROPERTY

SCHEDULE 5.11

BORROWER PRODUCTS

SCHEDULE 5.13

EMPLOYEE LOANS

SCHEDULE 5.14

CAPITALIZATION

SCHEDULE 7.24

POST-CLOSING ITEMS

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Form S-3 (Nos. 333-229377, 333-233161, 333-242372, 333-249544, 333-257422, 333-261871, 333-264459 and 333-266410) and Form S-8 (Nos. 333-221622, 333-223539, 333-230181, 333-230499, 333-233162, 333-237164, 333-239082, 333-254618, 333-263430 and 333-269335) of X4 Pharmaceuticals, Inc. of our report dated March 21, 2023 relating to the financial statements, which appears in this Form 10-K.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
March 21, 2023

CERTIFICATION

I, Paula Ragan, Ph.D., certify that:

1. I have reviewed this Annual Report on Form 10-K of X4 Pharmaceuticals, Inc.;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - d. Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 21, 2023

/s/ Paula Ragan, Ph.D.

Paula Ragan, Ph.D.
President and Chief Executive Officer
(Principal Executive Officer)

CERTIFICATION

I, Adam S. Mostafa, certify that:

1. I have reviewed this Annual Report on Form 10-K of X4 Pharmaceuticals, Inc.;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - a. Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - b. Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - c. Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - d. Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - a. All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - b. Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 21, 2023

/s/ Adam S. Mostafa

Adam S. Mostafa
Chief Financial Officer and Treasurer
(Principal Financial Officer)

CERTIFICATION

Pursuant to the requirement set forth in Rule 13a-14(b) of the Securities Exchange Act of 1934, as amended, (the "Exchange Act") and Section 1350 of Chapter 63 of Title 18 of the United States Code (18 U.S.C. §1350), Paula Ragan, Ph.D., Chief Executive Officer of X4 Pharmaceuticals, Inc. (the "Company"), and Adam S. Mostafa, Chief Financial Officer of the Company, each hereby certifies that, to the best of his or her knowledge:

1. The Company's Annual Report on Form 10-K for the fiscal year ended December 31, 2022, to which this Certification is attached as Exhibit 32.1 (the "Annual Report"), fully complies with the requirements of Section 13(a) or Section 15(d) of the Exchange Act; and
2. The information contained in the Annual Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

In Witness Whereof, the undersigned have set their hands hereto as of the 21st day of March, 2023.

/s/ Paula Ragan, Ph.D. /s/ Adam S. Mostafa

Paula Ragan, Ph.D. Adam S. Mostafa

Chief Executive Officer Chief Financial Officer

(Principal Executive Officer) *(Principal Financial Officer and Principal Accounting Officer)*