

**UNITED STATES
SECURITIES AND EXCHANGE COMMISSION**
Washington, D.C. 20549
FORM S-3
REGISTRATION STATEMENT
UNDER
THE SECURITIES ACT OF 1933

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 Number)

61 North Beacon Street, 4th Floor
Boston, Massachusetts 02134
(857) 529-8300

(Address, including zip code, and telephone number, including area code of registrant's principal executive offices)

Paula Ragan, Ph.D.
Chief Executive Officer
c/o X4 Pharmaceuticals, Inc.
61 North Beacon Street, 4th Floor
Boston, Massachusetts 02134
(857) 529-8300

(Name, address, including zip code, and telephone number, including area code, of agent for service)

Copies to:

Daniel I. Goldberg
Eric Blanchard
Courtney T. Thorne
Cooley LLP
55 Hudson Yards
New York, NY 1001-2157
(212) 479-6000

From time to time after the effective date of this Registration Statement
(Approximate date of commencement of proposed sale to the public)

If the only securities being registered on this Form are being offered pursuant to dividend or interest reinvestment plans, please check the following box.

If any of the securities being registered on this Form are to be offered on a delayed or continuous basis pursuant to Rule 415 under the Securities Act of 1933, other than securities offered only in connection with dividend or interest reinvestment plans, check the following box.

If this Form is filed to register additional securities for an offering pursuant to Rule 462(b) under the Securities Act, please check the following box and list the Securities Act registration statement number of the earlier effective registration statement for the same offering.

If this Form is a post-effective amendment filed pursuant to Rule 462(c) under the Securities Act, check the following box and list the Securities Act registration statement number of the earlier effective registration statement for the same offering.

If this Form is a registration statement pursuant to General Instruction I.D. or a post-effective amendment thereto that shall become effective upon filing with the Commission pursuant to Rule 462(e) under the Securities Act, check the following box

If this Form is a post-effective amendment to a registration statement filed pursuant to General Instruction I.D. filed to register additional securities or additional classes of securities pursuant to Rule 413(b) under the Securities Act, check the following box.

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

Accelerated filer

Non-accelerated filer

Smaller reporting company

Emerging growth company

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 7(a)(2)(B) of the Securities Act.

The registrant hereby amends this registration statement on such date or dates as may be necessary to delay its effective date until the registrant shall file a further amendment that specifically states that this registration statement shall thereafter become effective in accordance with Section 8(a) of the Securities Act or until the registration statement shall become effective on such date as the Securities and Exchange Commission, acting pursuant to said Section 8(a), may determine.

EXPLANATORY NOTE

We are filing this registration statement with the Securities and Exchange Commission, or the SEC, using a “shelf” registration process to replace our prior registration statements (File Nos. 333-242372 and 333-249544), or the prior registration statements, that will expire on August 18, 2023 and October 25, 2023, respectively, in accordance with applicable SEC regulations. Under this shelf registration statement, we may, from time to time, sell any combination of the securities described herein, in one or more offerings, up to a maximum aggregate offering price of \$300,000,000.

This Registration Statement of X4 Pharmaceuticals, Inc., or the Registrant, contains three prospectuses:

- a base prospectus, which covers the offering, issuance and sale by the Registrant of up to a maximum aggregate offering price of \$300,000,000 of its common stock, preferred stock, debt securities and/or warrants to purchase any of such securities from time to time in one or more offerings;
- a sales agreement prospectus covering the offering, issuance and sale by the Registrant of up to a maximum aggregate offering price of \$75,000,000 (which amount is included in the \$300,000,000 aggregate offering price set forth in the base prospectus) of its common stock that may be issued and sold under the Controlled Equity OfferingSM Sales Agreement dated August 7, 2020, by and among the Registrant, B. Riley Securities, Inc., Cantor Fitzgerald & Co., and Stifel, Nicolaus & Company, Incorporated, or the Sales Agreement; and
- a purchase agreement prospectus covering the offering, issuance and sale by the Registrant of up to a maximum aggregate offering price of \$50,000,000 of its common stock that may be issued and sold under a Purchase Agreement dated January 14, 2022, by and between the Registrant and Lincoln Park Capital Fund, LLC, or the Purchase Agreement, and 230,414 shares of common stock issued to Lincoln Park as consideration for its commitment to purchase shares of the Registrant's common stock under the Purchase Agreement (which amounts are included in the \$300,000,000 aggregate offering price set forth in the base prospectus).

The base prospectus immediately follows this explanatory note. The specific terms of any securities to be offered pursuant to the base prospectus will be specified in one or more prospectus supplements to the base prospectus. The prospectus related to the offering of shares of our common stock under the Sales Agreement immediately follows the base prospectus. In the event of the termination of the Sales Agreement, any portion of the \$75,000,000 included in the sales agreement prospectus contained in this registration statement that is not sold pursuant to the Sales Agreement will be available for sale in other offerings pursuant to the base prospectus, and if no shares are sold under the Sales Agreement, the full \$75,000,000 of securities may be sold in other offerings pursuant to the base prospectus and a corresponding prospectus supplement. The purchase agreement prospectus immediately follows the sales agreement prospectus. Upon termination of the Purchase Agreement, any portion of the \$50,000,000 included in the purchase agreement prospectus that is not sold pursuant to the Purchase Agreement will be available for sale in other offerings pursuant to the base prospectus, and if no shares are sold under the Purchase Agreement, the full \$50,000,000 of securities may be sold in other offerings pursuant to the base prospectus and a corresponding prospectus supplement.

The information in this prospectus is not complete and may be changed. We may not sell these securities or accept an offer to buy these securities until the registration statement filed with the Securities and Exchange Commission is effective. This prospectus is not an offer to sell these securities, and it is not soliciting offers to buy these securities in any jurisdiction where such offer or sale is not permitted.

SUBJECT TO COMPLETION, DATED AUGUST 11, 2023

PROSPECTUS



\$300,000,000

**Common Stock
Preferred Stock
Debt Securities
Warrants**

From time to time, we may offer up to \$300,000,000 of any combination of the securities described in this prospectus in one or more offerings. We may also offer securities as may be issuable upon conversion, redemption, repurchase, exchange or exercise of any securities registered hereunder, including any applicable anti-dilution provisions.

This prospectus provides a general description of the securities we may offer. Each time we offer securities, we will provide specific terms of the securities offered in a supplement to this prospectus. We may also authorize one or more free writing prospectuses to be provided to you in connection with these offerings. The prospectus supplement and any related free writing prospectus may also add, update or change information contained in this prospectus. You should carefully read this prospectus, the applicable prospectus supplement and any related free writing prospectus, as well as any documents incorporated by reference, before you invest in any of the securities being offered.

This prospectus may not be used to consummate a sale of any securities unless accompanied by a prospectus supplement.

Our common stock is traded on the Nasdaq Capital Market under the symbol "XFOR." On August 8, 2023, the closing sale price of our common stock was \$1.69 per share. The applicable prospectus supplement will contain information, where applicable, as to any other listing on the Nasdaq Capital Market or any securities market or other exchange of the securities, if any, covered by the applicable prospectus supplement.

We will sell these securities directly to investors, through agents designated from time to time or to or through underwriters or dealers, on a continuous or delayed basis. For additional information on the methods of sale, you should refer to the section titled "Plan of Distribution" in this prospectus. If any agents or underwriters are involved in the sale of any securities with respect to which this prospectus is being delivered, the names of such agents or underwriters and any applicable fees, commissions, discounts or options to purchase additional securities will be set forth in a prospectus supplement. The price to the public of such securities and the net proceeds we expect to receive from such sale will also be set forth in a prospectus supplement.

Investing in our securities involves a high degree of risk. You should review carefully the risks and uncertainties described under the heading “[Risk Factors](#)” contained in this prospectus beginning on page 5 and any applicable prospectus supplement and in any related free writing prospectus we have authorized for use in connection with a specific offering, and under similar headings in the other documents that are incorporated by reference into this prospectus.

NEITHER THE SECURITIES AND EXCHANGE COMMISSION NOR ANY STATE SECURITIES COMMISSION HAS APPROVED OR DISAPPROVED OF THESE SECURITIES OR DETERMINED IF THIS PROSPECTUS IS TRUTHFUL OR COMPLETE. ANY REPRESENTATION TO THE CONTRARY IS A CRIMINAL OFFENSE.

The date of this prospectus is , 2023.

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ABOUT THIS PROSPECTUS

This prospectus is a part of a registration statement on Form S-3 that we filed with the SEC utilizing a “shelf” registration process. Under this shelf registration process, we may sell any combination of the securities described in this prospectus in one or more offerings up to a total aggregate offering price of \$300,000,000. This prospectus provides you with a general description of the securities we may offer.

Each time we sell securities under this prospectus, we will provide a prospectus supplement that will contain specific information about the terms of that offering. We may also authorize one or more free writing prospectuses to be provided to you that may contain material information relating to these offerings. The prospectus supplement and any related free writing prospectus that we may authorize to be provided to you may also add, update or change information contained in this prospectus or in any documents that we have incorporated by reference into this prospectus. You should read this prospectus, any applicable prospectus supplement and any related free writing prospectus, together with the information incorporated herein by reference as described under the heading “Incorporation of Certain Information by Reference,” before investing in any of the securities offered.

THIS PROSPECTUS MAY NOT BE USED TO CONSUMMATE A SALE OF SECURITIES UNLESS IT IS ACCOMPANIED BY A PROSPECTUS SUPPLEMENT.

Neither we, nor any agent, underwriter or dealer has authorized any person to give any information or to make any representation other than those contained or incorporated by reference in this prospectus, any applicable prospectus supplement or any related free writing prospectus prepared by or on behalf of us or to which we have referred you. This prospectus, any applicable supplement to this prospectus or any related free writing prospectus do not constitute an offer to sell or the solicitation of an offer to buy any securities other than the registered securities to which they relate, nor do this prospectus, any applicable supplement to this prospectus or any related free writing prospectus constitute an offer to sell or the solicitation of an offer to buy securities in any jurisdiction to any person to whom it is unlawful to make such offer or solicitation in such jurisdiction.

You should not assume that the information contained in this prospectus, any applicable prospectus supplement or any related free writing prospectus is accurate on any date subsequent to the date set forth on the front of the document or that any information we have incorporated by reference is correct on any date subsequent to the date of the document incorporated by reference, even though this prospectus, any applicable prospectus supplement or any related free writing prospectus is delivered, or securities are sold, on a later date.

This prospectus and the information incorporated herein by reference contain summaries of certain provisions contained in some of the documents described herein, but reference is made to the actual documents for complete information. All of the summaries are qualified in their entirety by the actual documents. Copies of some of the documents referred to herein have been filed, will be filed or will be incorporated by reference as exhibits to the registration statement of which this prospectus is a part, and you may obtain copies of those documents as described below under the heading “Where You Can Find More Information.”

This prospectus and the information incorporated by reference herein include trademarks, service marks and trade names owned by us or other companies. All trademarks, service marks and trade names included or incorporated by reference into this prospectus are the property of their respective owners. Solely for convenience, the trademarks and trade names in this prospectus are referred to without the symbols ® and ™, but such references should not be construed as any indication that their respective owners will not assert, to the fullest extent under applicable law, their rights thereto.

PROSPECTUS SUMMARY

This summary highlights selected information contained elsewhere in this prospectus. This summary is not complete and does not contain all of the information that you need to consider in making your investment decision. You should carefully read the entire prospectus, the applicable prospectus supplement and any related free writing prospectus, including the risks of investing in our securities discussed under the heading “Risk Factors” contained in the applicable prospectus supplement and any related free writing prospectus, and under similar headings in the other documents that are incorporated by reference into this prospectus. You should also carefully read the information incorporated by reference into this prospectus, including our financial statements, and the exhibits to the registration statement of which this prospectus is a part.

Unless otherwise indicated or the context otherwise requires, the terms “Company,” “X4 Pharmaceuticals,” “X4,” “Registrant,” “we,” “us” and “our” refer to X4 Pharmaceuticals, Inc., formerly Arsanis, Inc., and its subsidiaries.

Company 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. We are also currently advancing mavorixafor in clinical trial in people with certain chronic neutropenic disorders.

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.

Corporate Information

Prior to March 13, 2019, we were a clinical-stage biopharmaceutical company known as Arsanis, Inc. that had historically been focused on applying monoclonal antibody immunotherapies to address serious infectious diseases. Arsanis, Inc. was originally incorporated in the State of Delaware in August 2010.

On March 13, 2019, we completed our business combination with X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) in accordance with the terms of an Agreement and Plan of Merger, dated as of November 26, 2018, as amended on December 20, 2018 and March 8, 2019 (the “Merger Agreement”), that we entered into with X4 Therapeutics, Inc. and Artemis AC Corp., a Delaware corporation and our wholly owned subsidiary, or the Merger Sub. Pursuant to the terms of the Merger Agreement, 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, which transaction we refer to as the Merger. At the closing of the Merger, we issued shares of our common stock to X4 Therapeutics, Inc. stockholders based on an agreed upon exchange ratio, and each option or warrant to purchase X4 Therapeutics, Inc. capital stock became an option or warrant, respectively, to purchase our common stock, subject to adjustment in accordance with the agreed upon exchange ratio. Following the closing of the Merger, we effected a 1-for-6 reverse stock split of our common stock, our name was changed to X4 Pharmaceuticals, Inc., the business of X4 Therapeutics, Inc. became our business, and we became a clinical-stage biopharmaceutical company focused on the discovery, development and commercialization of novel therapeutics for

the treatment of rare diseases. In connection with the closing of the Merger, our stock began trading on the Nasdaq Capital Market under the symbol "XFOR" on March 14, 2019.

Our principal executive offices are located at 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134, and our telephone number is (857) 529-8300. Our website is located at <http://www.x4pharma.com>. We do not incorporate by reference into this prospectus the information on, or accessible through, our website, and you should not consider it as part of this prospectus.

The Securities We May Offer

We may offer shares of our common stock, shares of our preferred stock, various series of debt securities and warrants to purchase any of such securities, up to a total aggregate offering price of \$300,000,000 from time to time in one or more offerings under this prospectus, together with any applicable prospectus supplement and any related free writing prospectus, at prices and on terms to be determined by market conditions at the time of the relevant offering. This prospectus provides you with a general description of the securities we may offer. Each time we offer a type or series of securities under this prospectus, we will provide a prospectus supplement that will describe the specific amounts, prices and other important terms of the securities, including, to the extent applicable:

- designation or classification;
- aggregate principal amount or aggregate offering price;
- maturity;
- original issue discount, if any;
- rates and times of payment of interest or dividends, if any;
- redemption, conversion, exchange or sinking fund terms, if any;
- conversion or exchange prices or rates, if any, and, if applicable, any provisions for changes to or adjustments in the conversion or exchange prices or rates and in the securities or other property receivable upon conversion or exchange;
- ranking;
- restrictive covenants, if any;
- voting or other rights, if any; and
- important U.S. federal income tax considerations.

The prospectus supplement and any related free writing prospectus that we may authorize to be provided to you may also add, update or change information contained in this prospectus or in documents we have incorporated by reference. However, no prospectus supplement or free writing prospectus will offer a security that is not registered and described in this prospectus at the time of the effectiveness of the registration statement of which this prospectus is a part.

We may sell the securities directly to investors or through underwriters, dealers or agents. We, and our underwriters or agents, reserve the right to accept or reject all or part of any proposed purchase of securities. If we do offer securities through underwriters or agents, we will include in the applicable prospectus supplement:

- the names of those underwriters or agents;
- applicable fees, discounts and commissions to be paid to them;
- details regarding options to purchase additional securities, if any; and
- the estimated net proceeds to us.

THIS PROSPECTUS MAY NOT BE USED TO CONSUMMATE A SALE OF ANY SECURITIES UNLESS IT IS ACCOMPANIED BY A PROSPECTUS SUPPLEMENT.

Common Stock. We may issue shares of our common stock from time to time. 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.

Preferred Stock. We may issue shares of our preferred stock from time to time, in one or more series. Under our restated certificate of incorporation, as amended, or restated certificate, our board of directors has the authority, without further action by the stockholders, to issue up to 10,000,000 shares of preferred stock, par value \$0.001 per share. As of the date of this prospectus, no shares of our preferred stock were outstanding or designated. You should refer to our restated certificate and our amended and restated by-laws, or restated by-laws, both of which are included as exhibits to the registration statement of which this prospectus is a part.

Our board of directors may, without further action by our stockholders, from time to time, direct the issuance of shares of preferred stock in series and may, at the time of issuance, determine the rights, preferences and limitations of each series, including voting rights, dividend rights and redemption and liquidation preferences. Satisfaction of any dividend preferences of outstanding shares of preferred stock would reduce the amount of funds available for the payment of dividends on shares of our common stock. Holders of shares of preferred stock may be entitled to receive a preference payment in the event of any liquidation, dissolution or winding-up of our company before any payment is made to the holders of shares of our common stock. In some circumstances, the issuance of shares of preferred stock may render more difficult or tend to discourage a merger, tender offer or proxy contest, the assumption of control by a holder of a large block of our securities or the removal of incumbent management. Upon the affirmative vote of our board of directors, without stockholder approval, we may issue shares of preferred stock with voting and conversion rights which could adversely affect the holders of shares of our common stock.

If we offer a specific series of preferred stock under this prospectus, we will describe the terms of the preferred stock in the prospectus supplement for such offering and will file a copy of the restated certificate establishing the terms of the preferred stock with the SEC. We urge you to read the applicable prospectus supplement (and any free writing prospectus that we may authorize to be provided to you) related to the series of preferred stock being offered, as well as the complete certificate of designation that contains the terms of the applicable series of preferred stock.

Debt Securities. We may issue debt securities from time to time, in one or more series, as either senior or subordinated debt or as senior or subordinated convertible debt. The senior debt securities will rank equally with any other unsecured and unsubordinated debt. The subordinated debt securities will be subordinate and junior in right of payment, to the extent and in the manner described in the instrument governing the debt, to all of our senior indebtedness. Convertible debt securities will be convertible into or exchangeable for our common stock or other securities. Conversion may be mandatory or at the holder's option and would be at prescribed conversion rates.

The debt securities will be issued under one or more documents called indentures, which are contracts between us and a national banking association or other eligible party, as trustee. In this prospectus, we have summarized certain general features of the debt securities. We urge you, however, to read the applicable prospectus supplement (and any free writing prospectus that we may authorize to be provided to you) related to the series of debt securities being offered, as well as the complete indentures that contain the terms of the debt securities. A form of indenture has been filed as an exhibit to the registration statement of which this prospectus is a part, and supplemental indentures and

forms of debt securities containing the terms of the debt securities being offered will be filed as exhibits to the registration statement of which this prospectus is a part or will be incorporated by reference from reports that we file with the SEC.

Warrants. We may issue warrants for the purchase of common stock, preferred stock and/or debt securities, in one or more series, from time to time. We may issue warrants independently or together with common stock, preferred stock and/or debt securities, and the warrants may be attached to or separate from these securities. In this prospectus, we have summarized certain general features of the warrants. We urge you, however, to read the applicable prospectus supplement (and any free writing prospectus that we may authorize to be provided to you) related to the particular series of warrants being offered, as well as the complete warrant agreements and warrant certificates that contain the terms of the warrants. Forms of the warrant agreements and forms of warrant certificates containing the terms of the warrants being offered have been filed as exhibits to the registration statement of which this prospectus is a part, and supplemental warrant agreements and forms of warrant certificates will be filed as exhibits to the registration statement of which this prospectus is a part or will be incorporated by reference from reports that we file with the SEC.

We will evidence each series of warrants by warrant certificates that we will issue. Warrants may be issued under an applicable warrant agreement that we enter into with a warrant agent. We will indicate the name and address of the warrant agent, if applicable, in the prospectus supplement relating to the particular series of warrants being offered.

RISK FACTORS

Investing in our securities involves a high degree of risk. You should carefully review the risks and uncertainties described under the heading “Risk Factors” contained in the applicable prospectus supplement and any related free writing prospectus, and under similar headings in our Annual Report on Form 10-K for the year ended December 31, 2022, as updated by any subsequently filed periodic reports and other documents that are incorporated by reference into this prospectus, before deciding whether to purchase any of the securities being registered pursuant to the registration statement of which this prospectus is a part. Each of the risk factors described in the documents referenced above could adversely affect our business, operating results and financial condition, as well as adversely affect the value of an investment in our securities, and the occurrence of any of these risks might cause you to lose all or part of your investment. Additional risks not presently known to us or that we currently believe are immaterial may also significantly impair our business operations.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This prospectus, each prospectus supplement and the information incorporated by reference in this prospectus and each prospectus supplement contain forward-looking statements. These are based on our management's current beliefs, expectations and assumptions about future events, conditions and results and on information currently available to us. Discussions containing these forward-looking statements may be found, among other places, in the sections titled "Business," "Risk Factors" and "Management's Discussion and Analysis of Financial Condition and Results of Operations" contained in the documents incorporated by reference herein.

Any statements in this prospectus, or incorporated herein by reference, about our expectations, beliefs, plans, objectives, assumptions or future events or performance are not historical facts and are forward-looking statements. Within the meaning of Section 27A of the Securities Act of 1933, as amended, or the Securities Act, and Section 21E of the Securities Exchange Act of 1934, as amended, or the Exchange Act, these forward-looking statements include statements regarding:

- 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 caption “Risk Factors” in our most recent Annual Report on Form 10-K, our most recent Quarterly Report on Form 10-Q, and other filings we make with the SEC.

In some cases, you can identify forward-looking statements by the words “may,” “might,” “can,” “will,” “to be,” “could,” “would,” “should,” “expect,” “intend,” “plan,” “objective,” “anticipate,” “believe,” “estimate,” “predict,” “project,” “potential,” “likely,” “continue” and “ongoing,” or the negative of these terms, or other comparable terminology intended to identify statements about the future, although not all forward-looking statements contain these words. These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, levels of activity, performance or achievements to be materially different from the information expressed or implied by these forward-looking statements.

You should refer to the “Risk Factors” section contained in the applicable prospectus supplement and any related free writing prospectus, and under similar headings in the other documents that are incorporated by reference into this prospectus, 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. Given these risks, uncertainties and other factors, many of which are beyond our control, we cannot assure you that the forward-looking statements in this prospectus will prove to be accurate, and you should not place undue reliance on these forward-looking statements. 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.

Except as required by law, we assume no obligation to update these forward-looking statements publicly, or to revise any forward-looking statements to reflect events or developments occurring after the date of this prospectus, even if new information becomes available in the future.

USE OF PROCEEDS

We will retain broad discretion over the use of the net proceeds from the sale of the securities offered hereby. Except as described in any applicable prospectus supplement or in any free writing prospectuses that we may authorize to be provided to you in connection with a specific offering, we currently intend to use the net proceeds from the sale of the securities offered hereby, if any, for working capital and general corporate purposes, including research and development expenses and capital expenditures, which may include costs of funding future acquisitions or for any other purpose we describe in the applicable prospectus supplement. We will set forth in the applicable prospectus supplement or free writing prospectus our intended use for the net proceeds received from the sale of any securities sold pursuant to the prospectus supplement or free writing prospectus. Pending the use of net proceeds, we plan to invest the net proceeds in short-term interest-bearing investment-grade securities, certificates of deposit or government securities.

DESCRIPTION OF CAPITAL STOCK

The following description of our capital stock and certain provisions of our restated certificate of incorporation, as amended, or restated certificate, and amended and restated by-laws are summaries. You should also refer to the restated certificate and the amended and restated by-laws, which are filed as exhibits to the registration statement of which this prospectus is part, and to the applicable provisions of Delaware law.

General

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, all of which shares of preferred stock are undesignated. Our board of directors may establish the rights and preferences of the preferred stock from time to time. As of August 8, 2023, we had outstanding 164,424,897 shares of common stock and no shares of preferred stock outstanding.

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.

Preferred Stock

Our board of directors may, without further action by our stockholders, from time to time, direct the issuance of shares of up to 10,000,000 shares of preferred stock in series and may, at the time of issuance, determine the rights, preferences and limitations of each series, including voting rights, dividend rights and redemption and liquidation preferences. Satisfaction of any dividend preferences of outstanding shares of preferred stock would reduce the amount of funds available for the payment of dividends on shares of our common stock. Holders of shares of preferred stock may be entitled to receive a preference payment in the event of any liquidation, dissolution or winding-up of our company before any payment is made to the holders of shares of our common stock. In some circumstances, the issuance of shares of preferred stock may render more difficult or tend to discourage a merger, tender offer or proxy contest, the assumption of control by a holder of a large block of our securities or the removal of incumbent management. Upon the affirmative vote of our board of directors, without stockholder approval, we may issue shares of preferred stock with voting and conversion rights which could adversely affect the holders of shares of our common stock.

Our board of directors will fix the designations, voting powers, preferences and rights of each series, as well as the qualifications, limitations or restrictions thereof, of the preferred stock of each series that we offer under this prospectus and applicable prospectus supplements in the certificate of designation relating to that series. We will file as an exhibit to the registration statement of which this prospectus is a part, or will incorporate by reference from reports that we file with the SEC, the form of any certificate of designation that describes the terms of the series of preferred stock we are offering before the issuance of that series of preferred stock. This description will include:

- the title and stated value;
- the number of shares we are offering;
- the liquidation preference per share;
- the purchase price per share;
- the dividend rate per share, dividend period and payment dates and method of calculation for dividends;
- whether dividends will be cumulative or non-cumulative and, if cumulative, the date from which dividends will accumulate;
- our right, if any, to defer payment of dividends and the maximum length of any such deferral period;
- the procedures for any auction and remarketing, if any;
- the provisions for a sinking fund, if any;
- the provisions for redemption or repurchase, if applicable, and any restrictions on our ability to exercise those redemption and repurchase rights;
- any listing of the preferred stock on any securities exchange or market;
- whether the preferred stock will be convertible into our common stock or other securities of ours, including depositary shares and warrants, and, if applicable, the conversion period, the conversion price, or how it will be calculated, and under what circumstances it may be adjusted;
- whether the preferred stock will be exchangeable into debt securities, and, if applicable, the exchange period, the exchange price, or how it will be calculated, and under what circumstances it may be adjusted;
- voting rights, if any, of the preferred stock;
- preemption rights, if any;
- restrictions on transfer, sale or other assignment, if any;
- whether interests in the preferred stock will be represented by depositary shares;
- a discussion of any material or special U.S. federal income tax considerations applicable to the preferred stock;
- the relative ranking and preferences of the preferred stock as to dividend rights and rights if we liquidate, dissolve or wind up our affairs;
- any limitations on issuances of any class or series of preferred stock ranking senior to or on a parity with the series of preferred stock being issued as to dividend rights and rights if we liquidate, dissolve or wind up our affairs; and
- any other specific terms, rights, preferences, privileges, qualifications or restrictions of the preferred stock.

The General Corporation Law of the State of Delaware, or DGCL, the state of our incorporation, provides that the holders of preferred stock will have the right to vote separately as a class (or, in some cases, as a series) on an amendment to our certificate of incorporation if the amendment would change the par value or, unless the certificate of incorporation provided otherwise, the number of authorized shares of the class or change the powers, preferences or special rights of the class or series so as to adversely affect the class or series, as the case may be. This right is in addition to any voting rights that may be provided for in the applicable certificate of designation.

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 such 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.

Section 203 could prohibit or delay mergers or other takeover or change in control attempts and, accordingly, may discourage attempts to acquire us even though such a transaction may offer our stockholders the opportunity to sell their stock at a price above the prevailing market price.

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 and preferred 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 and preferred 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 Securities Act creates 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 150 Royall Street, Canton, Massachusetts 02021. The transfer agent for any series of preferred stock that we may offer under this prospectus will be named and described in the prospectus supplement for that series.

Listing on Nasdaq

Our common stock is listed on the Nasdaq Capital Market under the symbol “XFOR.”

DESCRIPTION OF DEBT SECURITIES

We may issue debt securities from time to time, in one or more series, as either senior or subordinated debt or as senior or subordinated convertible debt. While the terms we have summarized below will apply generally to any debt securities that we may offer under this prospectus, we will describe the particular terms of any debt securities that we may offer in more detail in the applicable prospectus supplement. The terms of any debt securities offered under a prospectus supplement may differ from the terms described below. Unless the context requires otherwise, whenever we refer to the indenture, we also are referring to any supplemental indentures that specify the terms of a particular series of debt securities.

We will issue the debt securities under the indenture that we will enter into with the trustee named in the indenture. The indenture will be qualified under the Trust Indenture Act of 1939, as amended, or the Trust Indenture Act. We have filed the form of indenture as an exhibit to the registration statement of which this prospectus is a part, and supplemental indentures and forms of debt securities containing the terms of the debt securities being offered will be filed as exhibits to the registration statement of which this prospectus is a part or will be incorporated by reference from reports that we file with the SEC.

The following summary of material provisions of the debt securities and the indenture is subject to, and qualified in its entirety by reference to, all of the provisions of the indenture applicable to a particular series of debt securities. We urge you to read the applicable prospectus supplements and any related free writing prospectuses related to the debt securities that we may offer under this prospectus, as well as the complete indenture that contains the terms of the debt securities.

General

The indenture does not limit the amount of debt securities that we may issue. It provides that we may issue debt securities up to the principal amount that we may authorize and may be in any currency or currency unit that we may designate. Except for the limitations on consolidation, merger and sale of all or substantially all of our assets contained in the indenture, the terms of the indenture do not contain any covenants or other provisions designed to give holders of any debt securities protection against changes in our operations, financial condition or transactions involving us.

We may issue the debt securities issued under the indenture as “discount securities,” which means they may be sold at a discount below their stated principal amount. These debt securities, as well as other debt securities that are not issued at a discount, may be issued with “original issue discount,” or OID, for U.S. federal income tax purposes because of interest payment and other characteristics or terms of the debt securities. Material U.S. federal income tax considerations applicable to debt securities issued with OID will be described in more detail in any applicable prospectus supplement.

We will describe in the applicable prospectus supplement the terms of the series of debt securities being offered, including:

- the title of the series of debt securities;
- any limit upon the aggregate principal amount that may be issued;
- the maturity date or dates;
- the form of the debt securities of the series;
- the applicability of any guarantees;
- whether or not the debt securities will be secured or unsecured, and the terms of any secured debt;

- whether the debt securities rank as senior debt, senior subordinated debt, subordinated debt or any combination thereof, and the terms of any subordination;
- if the price (expressed as a percentage of the aggregate principal amount thereof) at which such debt securities will be issued is a price other than the principal amount thereof, the portion of the principal amount thereof payable upon declaration of acceleration of the maturity thereof, or if applicable, the portion of the principal amount of such debt securities that is convertible into another security or the method by which any such portion shall be determined;
- the interest rate or rates, which may be fixed or variable, or the method for determining the rate and the date interest will begin to accrue, the dates interest will be payable and the regular record dates for interest payment dates or the method for determining such dates;
- our right, if any, to defer payment of interest and the maximum length of any such deferral period;
- if applicable, the date or dates after which, or the period or periods during which, and the price or prices at which, we may, at our option, redeem the series of debt securities pursuant to any optional or provisional redemption provisions and the terms of those redemption provisions;
- the date or dates, if any, on which, and the price or prices at which we are obligated, pursuant to any mandatory sinking fund or analogous fund provisions or otherwise, to redeem, or at the holder's option to purchase, the series of debt securities and the currency or currency unit in which the debt securities are payable;
- the denominations in which we will issue the series of debt securities, if other than denominations of \$1,000 and any integral multiple thereof;
- any and all terms, if applicable, relating to any auction or remarketing of the debt securities of that series and any security for our obligations with respect to such debt securities and any other terms which may be advisable in connection with the marketing of debt securities of that series;
- whether the debt securities of the series shall be issued in whole or in part in the form of a global security or securities;
- the terms and conditions, if any, upon which such global security or securities may be exchanged in whole or in part for other individual securities;
- the depositary for such global security or securities;
- if applicable, the provisions relating to conversion or exchange of any debt securities of the series and the terms and conditions upon which such debt securities will be so convertible or exchangeable, including the conversion or exchange price, as applicable, or how it will be calculated and may be adjusted, any mandatory or optional (at our option or the holders' option) conversion or exchange features, the applicable conversion or exchange period and the manner of settlement for any conversion or exchange;
- if other than the full principal amount thereof, the portion of the principal amount of debt securities of the series which shall be payable upon declaration of acceleration of the maturity thereof;
- additions to or changes in the covenants applicable to the particular debt securities being issued, including, among others, the consolidation, merger or sale covenant;
- additions to or changes in the events of default with respect to the securities and any change in the right of the trustee or the holders to declare the principal, premium, if any, and interest, if any, with respect to such securities to be due and payable;
- additions to or changes in or deletions of the provisions relating to covenant defeasance and legal defeasance;

- additions to or changes in the provisions relating to satisfaction and discharge of the indenture;
- additions to or changes in the provisions relating to the modification of the indenture both with and without the consent of holders of debt securities issued under the indenture;
- the currency of payment of debt securities if other than U.S. dollars and the manner of determining the equivalent amount in U.S. dollars;
- whether interest will be payable in cash or additional debt securities at our or the holders' option and the terms and conditions upon which the election may be made;
- the terms and conditions, if any, upon which we will pay amounts in addition to the stated interest, premium, if any and principal amounts of the debt securities of the series to any holder that is not a "United States person" for federal tax purposes;
- any restrictions on transfer, sale or assignment of the debt securities of the series; and
- any other specific terms, preferences, rights or limitations of, or restrictions on, the debt securities, any other additions or changes in the provisions of the indenture, and any terms that may be required by us or advisable under applicable laws or regulations.

Conversion or Exchange Rights

We will set forth in the applicable prospectus supplement the terms on which a series of debt securities may be convertible into or exchangeable for our common stock or our other securities. We will include provisions as to settlement upon conversion or exchange and whether conversion or exchange is mandatory, at the option of the holder or at our option. We may include provisions pursuant to which the number of shares of our common stock or our other securities that the holders of the series of debt securities receive would be subject to adjustment.

Consolidation, Merger or Sale

Unless we provide otherwise in the prospectus supplement applicable to a particular series of debt securities, the indenture will not contain any covenant that restricts our ability to merge or consolidate, or sell, convey, transfer or otherwise dispose of our assets as an entirety or substantially as an entirety. However, any successor to or acquirer of such assets (other than a subsidiary of ours) must assume all of our obligations under the indenture or the debt securities, as appropriate.

Events of Default under the Indenture

Unless we provide otherwise in the prospectus supplement applicable to a particular series of debt securities, the following are events of default under the indenture with respect to any series of debt securities that we may issue:

- if we fail to pay any installment of interest on any series of debt securities, as and when the same shall become due and payable, and such default continues for a period of 90 days; provided, however, that a valid extension of an interest payment period by us in accordance with the terms of any indenture supplemental thereto shall not constitute a default in the payment of interest for this purpose;
- if we fail to pay the principal of, or premium, if any, on any series of debt securities as and when the same shall become due and payable whether at maturity, upon redemption, by declaration or otherwise, or in any payment required by any sinking or analogous fund established with respect to such series; provided, however, that a valid extension of the maturity of such debt securities in accordance with the terms of any indenture supplemental thereto shall not constitute a default in the payment of principal or premium, if any;
- if we fail to observe or perform any other covenant or agreement contained in the debt securities or the indenture, other than a covenant specifically relating to another series of debt securities, and our failure continues for 90 days after we receive written notice of such failure, requiring the same to be remedied

and stating that such is a notice of default thereunder, from the trustee or holders of at least 25% in aggregate principal amount of the outstanding debt securities of the applicable series; and

- if specified events of bankruptcy, insolvency or reorganization occur.

If an event of default with respect to debt securities of any series occurs and is continuing, other than an event of default specified in the last bullet point above, the trustee or the holders of at least 25% in aggregate principal amount of the outstanding debt securities of that series, by notice to us in writing, and to the trustee if notice is given by such holders, may declare the unpaid principal of, premium, if any, and accrued interest, if any, due and payable immediately. If an event of default specified in the last bullet point above occurs with respect to us, the principal amount of and accrued interest, if any, of each issue of debt securities then outstanding shall be due and payable without any notice or other action on the part of the trustee or any holder.

The holders of a majority in principal amount of the outstanding debt securities of an affected series may waive any default or event of default with respect to the series and its consequences, except defaults or events of default regarding payment of principal, premium, if any, or interest, unless we have cured the default or event of default in accordance with the indenture. Any waiver shall cure the default or event of default.

Subject to the terms of the indenture, if an event of default under an indenture shall occur and be continuing, the trustee will be under no obligation to exercise any of its rights or powers under such indenture at the request or direction of any of the holders of the applicable series of debt securities, unless such holders have offered the trustee reasonable indemnity. The holders of a majority in principal amount of the outstanding debt securities of any series will have the right to direct the time, method and place of conducting any proceeding for any remedy available to the trustee, or exercising any trust or power conferred on the trustee, with respect to the debt securities of that series, provided that:

- the direction so given by the holder is not in conflict with any law or the applicable indenture; and
- subject to its duties under the Trust Indenture Act, the trustee need not take any action that might involve it in personal liability or might be unduly prejudicial to the holders not involved in the proceeding.

A holder of the debt securities of any series will have the right to institute a proceeding under the indenture or to appoint a receiver or trustee, or to seek other remedies only if:

- the holder has given written notice to the trustee of a continuing event of default with respect to that series;
- the holders of at least 25% in aggregate principal amount of the outstanding debt securities of that series have made written request,
- such holders have offered to the trustee indemnity satisfactory to it against the costs, expenses and liabilities to be incurred by the trustee in compliance with the request; and
- the trustee does not institute the proceeding, and does not receive from the holders of a majority in aggregate principal amount of the outstanding debt securities of that series other conflicting directions within 90 days after the notice, request and offer.

These limitations do not apply to a suit instituted by a holder of debt securities if we default in the payment of the principal, premium, if any, or interest on, the debt securities.

We will periodically file statements with the trustee regarding our compliance with specified covenants in the indenture.

Modification of Indenture; Waiver

We and the trustee may change an indenture without the consent of any holders with respect to specific matters:

- to cure any ambiguity, defect or inconsistency in the indenture or in the debt securities of any series;

- to comply with the provisions described above under “Description of Debt Securities—Consolidation, Merger or Sale;”
- to provide for uncertificated debt securities in addition to or in place of certificated debt securities;
- to add to our covenants, restrictions, conditions or provisions such new covenants, restrictions, conditions or provisions for the benefit of the holders of all or any series of debt securities, to make the occurrence, or the occurrence and the continuance, of a default in any such additional covenants, restrictions, conditions or provisions an event of default or to surrender any right or power conferred upon us in the indenture;
- to add to, delete from or revise the conditions, limitations, and restrictions on the authorized amount, terms, or purposes of issue, authentication and delivery of debt securities, as set forth in the indenture;
- to make any change that does not adversely affect the interests of any holder of debt securities of any series in any material respect;
- to provide for the issuance of and establish the form and terms and conditions of the debt securities of any series as provided above under “Description of Debt Securities—General” to establish the form of any certifications required to be furnished pursuant to the terms of the indenture or any series of debt securities, or to add to the rights of the holders of any series of debt securities;
- to evidence and provide for the acceptance of appointment under any indenture by a successor trustee; or
- to comply with any requirements of the SEC in connection with the qualification of any indenture under the Trust Indenture Act.

In addition, under the indenture, the rights of holders of a series of debt securities may be changed by us and the trustee with the written consent of the holders of at least a majority in aggregate principal amount of the outstanding debt securities of each series that is affected. However, unless we provide otherwise in the prospectus supplement applicable to a particular series of debt securities, we and the trustee may make the following changes only with the consent of each holder of any outstanding debt securities affected:

- extending the fixed maturity of any debt securities of any series;
- reducing the principal amount, reducing the rate of or extending the time of payment of interest, or reducing any premium payable upon the redemption of any series of any debt securities; or
- reducing the percentage of debt securities, the holders of which are required to consent to any amendment, supplement, modification or waiver.

Discharge

Each indenture provides that we can elect to be discharged from our obligations with respect to one or more series of debt securities, except for specified obligations, including obligations to:

- provide for payment;
- register the transfer or exchange of debt securities of the series;
- replace stolen, lost or mutilated debt securities of the series;
- pay principal of and premium and interest on any debt securities of the series;
- maintain paying agencies;
- hold monies for payment in trust;
- recover excess money held by the trustee;

- compensate and indemnify the trustee; and
- appoint any successor trustee.

In order to exercise our rights to be discharged, we must deposit with the trustee money or government obligations sufficient to pay all the principal of, any premium, if any, and interest on, the debt securities of the series on the dates payments are due.

Form, Exchange and Transfer

We will issue the debt securities of each series only in fully registered form without coupons and, unless we provide otherwise in the applicable prospectus supplement, in denominations of \$1,000 and any integral multiple thereof. The indenture provides that we may issue debt securities of a series in temporary or permanent global form and as book-entry securities that will be deposited with, or on behalf of, The Depository Trust Company, or DTC, or another depository named by us and identified in the applicable prospectus supplement with respect to that series. To the extent the debt securities of a series are issued in global form and as book-entry, a description of terms relating to any book-entry securities will be set forth in the applicable prospectus supplement.

At the option of the holder, subject to the terms of the indenture and the limitations applicable to global securities described in the applicable prospectus supplement, the holder of the debt securities of any series can exchange the debt securities for other debt securities of the same series, in any authorized denomination and of like tenor and aggregate principal amount.

Subject to the terms of the indenture and the limitations applicable to global securities set forth in the applicable prospectus supplement, holders of the debt securities may present the debt securities for exchange or for registration of transfer, duly endorsed or with the form of transfer endorsed thereon duly executed if so required by us or the security registrar, at the office of the security registrar or at the office of any transfer agent designated by us for this purpose. Unless otherwise provided in the debt securities that the holder presents for transfer or exchange, we will impose no service charge for any registration of transfer or exchange, but we may require payment of any taxes or other governmental charges.

We will name in the applicable prospectus supplement the security registrar, and any transfer agent in addition to the security registrar, that we initially designate for any debt securities. We may at any time designate additional transfer agents or rescind the designation of any transfer agent or approve a change in the office through which any transfer agent acts, except that we will be required to maintain a transfer agent in each place of payment for the debt securities of each series.

If we elect to redeem the debt securities of any series, we will not be required to:

- issue, register the transfer of, or exchange any debt securities of that series during a period beginning at the opening of business 15 days before the day of mailing of a notice of redemption of any debt securities that may be selected for redemption and ending at the close of business on the day of the mailing; or
- register the transfer of or exchange any debt securities so selected for redemption, in whole or in part, except the unredeemed portion of any debt securities we are redeeming in part.

Information Concerning the Trustee

The trustee, other than during the occurrence and continuance of an event of default under an indenture, undertakes to perform only those duties as are specifically set forth in the applicable indenture. Upon an event of default under an indenture, the trustee must use the same degree of care as a prudent person would exercise or use in the conduct of his or her own affairs. Subject to this provision, the trustee is under no obligation to exercise any of the powers given it by the indenture at the request of any holder of debt securities unless it is offered reasonable security and indemnity against the costs, expenses and liabilities that it might incur.

Payment and Paying Agents

Unless we otherwise indicate in the applicable prospectus supplement, we will make payment of the interest on any debt securities on any interest payment date to the person in whose name the debt securities, or one or more predecessor securities, are registered at the close of business on the regular record date for the interest.

We will pay principal of and any premium and interest on the debt securities of a particular series at the office of the paying agents designated by us, except that unless we otherwise indicate in the applicable prospectus supplement, we will make interest payments by check that we will mail to the holder or by wire transfer to certain holders.

Unless we otherwise indicate in the applicable prospectus supplement, we will designate the corporate trust office of the trustee as our sole paying agent for payments with respect to debt securities of each series. We will name in the applicable prospectus supplement any other paying agents that we initially designate for the debt securities of a particular series. We will maintain a paying agent in each place of payment for the debt securities of a particular series.

All money we pay to a paying agent or the trustee for the payment of the principal of or any premium or interest on any debt securities that remains unclaimed at the end of two years after such principal, premium or interest has become due and payable will be repaid to us, and the holder of the debt security thereafter may look only to us for payment thereof.

Governing Law

The indenture and the debt securities will be governed by and construed in accordance with the internal laws of the State of New York, except to the extent that the Trust Indenture Act is applicable.

DESCRIPTION OF WARRANTS

The following description, together with the additional information we may include in any applicable prospectus supplements and free writing prospectuses, summarizes the material terms and provisions of the warrants that we may offer under this prospectus, which may consist of warrants to purchase common stock, preferred stock or debt securities and may be issued in one or more series. Warrants may be issued independently or together with common stock, preferred stock or debt securities offered by any prospectus supplement, and may be attached to or separate from those securities. While the terms we have summarized below will apply generally to any warrants that we may offer under this prospectus, we will describe the particular terms of any series of warrants that we may offer in more detail in the applicable prospectus supplement and any applicable free writing prospectus. The terms of any warrants offered under a prospectus supplement may differ from the terms described below. However, no prospectus supplement will offer a security that is not registered and described in this prospectus at the time of its effectiveness.

We have filed forms of the warrant agreements and forms of warrant certificates containing the terms of the warrants being offered as exhibits to the registration statement of which this prospectus is a part. We will file as exhibits to the registration statement of which this prospectus is a part, or will incorporate by reference from reports that we file with the SEC, the form of warrant agreement, if any, including a form of warrant certificate, that describes the terms of the particular series of warrants we are offering. The following summaries of material provisions of the warrants and the warrant agreements are subject to, and qualified in their entirety by reference to, all the provisions of the warrant agreement and warrant certificate applicable to the particular series of warrants that we may offer under this prospectus. We urge you to read the applicable prospectus supplements related to the particular series of warrants that we may offer under this prospectus, as well as any related free writing prospectuses, and the complete warrant agreements and warrant certificates that contain the terms of the warrants.

General

We will describe in the applicable prospectus supplement the terms relating to a series of warrants being offered, including:

- the title of such securities;
- the offering price or prices and aggregate number of warrants offered;
- the currency or currencies for which the warrants may be purchased;
- if applicable, the designation and terms of the securities with which the warrants are issued and the number of warrants issued with each such security or each principal amount of such security;
- if applicable, the date on and after which the warrants and the related securities will be separately transferable;
- if applicable, the minimum or maximum amount of such warrants which may be exercised at any one time;
- in the case of warrants to purchase common stock, the number of shares of common stock purchasable upon the exercise of one warrant and the price at which, and the currency in which, these shares may be purchased upon such exercise;
- in the case of warrants to purchase preferred stock, the number of shares of preferred stock purchasable upon the exercise of one warrant and the price at which, and the currency in which, these shares may be purchased upon such exercise;
- in the case of warrants to purchase debt securities, the principal amount of debt securities purchasable upon exercise of one warrant and the price at which, and currency in which, this principal amount of debt securities may be purchased upon such exercise;

- the effect of any merger, consolidation, sale or other disposition of our business on the warrant agreements and the warrants;
- the terms of any rights to redeem or call the warrants;
- the terms of any rights to force the exercise of the warrants;
- any provisions for changes to or adjustments in the exercise price or number of securities issuable upon exercise of the warrants;
- the dates on which the right to exercise the warrants will commence and expire;
- the manner in which the warrant agreements and warrants may be modified;
- a discussion of any material or special U.S. federal income tax consequences of holding or exercising the warrants;
- the terms of the securities issuable upon exercise of the warrants; and
- any other specific terms, preferences, rights or limitations of or restrictions on the warrants.

Before exercising their warrants, holders of warrants will not have any of the rights of holders of the securities purchasable upon such exercise, including:

- in the case of warrants to purchase common stock, the right to receive dividends, if any, or, payments upon our liquidation, dissolution or winding up or to exercise voting rights, if any;
- in the case of warrants to purchase preferred stock, the right to receive dividends, if any, or, payments upon our liquidation, dissolution or winding up or to exercise voting rights, if any; or
- in the case of warrants to purchase debt securities, the right to receive payments of principal of, or premium, if any, or interest on, the debt securities purchasable upon exercise or to enforce covenants in the applicable indenture.

Exercise of Warrants

Each warrant will entitle the holder to purchase the securities that we specify in the applicable prospectus supplement at the exercise price that we describe in the applicable prospectus supplement. Unless we otherwise specify in the applicable prospectus supplement, holders of the warrants may exercise the warrants at any time up to the specified time on the expiration date that we set forth in the applicable prospectus supplement. After the close of business on the expiration date, unexercised warrants will become void.

Unless we otherwise specify in the applicable prospectus supplement, holders of the warrants may exercise the warrants by delivering the warrant certificate representing the warrants to be exercised together with specified information, and paying the required amount to the warrant agent in immediately available funds, as provided in the applicable prospectus supplement. We will set forth on the reverse side of the warrant certificate and in the applicable prospectus supplement the information that the holder of the warrant will be required to deliver to the warrant agent in connection with the exercise of the warrant.

Upon receipt of the required payment and the warrant certificate properly completed and duly executed at the corporate trust office of the warrant agent or any other office indicated in the applicable prospectus supplement, we will issue and deliver the securities purchasable upon such exercise. If fewer than all of the warrants represented by the warrant certificate are exercised, then we will issue a new warrant certificate for the remaining amount of warrants. If we so indicate in the applicable prospectus supplement, holders of the warrants may surrender securities as all or part of the exercise price for warrants.

Governing Law

Unless we provide otherwise in the applicable prospectus supplement, the warrants and warrant agreements, and any claim, controversy or dispute arising under or related to the warrants or warrant agreements, will be governed by and construed in accordance with the laws of the State of New York.

Enforceability of Rights by Holders of Warrants

Each warrant agent will act solely as our agent under the applicable warrant agreement and will not assume any obligation or relationship of agency or trust with any holder of any warrant. A single bank or trust company may act as warrant agent for more than one issue of warrants. A warrant agent will have no duty or responsibility in case of any default by us under the applicable warrant agreement or warrant, including any duty or responsibility to initiate any proceedings at law or otherwise, or to make any demand upon us. Any holder of a warrant may, without the consent of the related warrant agent or the holder of any other warrant, enforce by appropriate legal action its right to exercise, and receive the securities purchasable upon exercise of, its warrants.

LEGAL OWNERSHIP OF SECURITIES

We can issue securities in registered form or in the form of one or more global securities. We describe global securities in greater detail below. We refer to those persons who have securities registered in their own names on the books that we or any applicable trustee or depositary maintain for this purpose as the “holders” of those securities. These persons are the legal holders of the securities. We refer to those persons who, indirectly through others, own beneficial interests in securities that are not registered in their own names, as “indirect holders” of those securities. As we discuss below, indirect holders are not legal holders, and investors in securities issued in book-entry form or in street name will be indirect holders.

Book-Entry Holders

We may issue securities in book-entry form only, as we will specify in the applicable prospectus supplement. This means securities may be represented by one or more global securities registered in the name of a financial institution that holds them as depositary on behalf of other financial institutions that participate in the depositary’s book-entry system. These participating institutions, which are referred to as participants, in turn, hold beneficial interests in the securities on behalf of themselves or their customers.

Only the person in whose name a security is registered is recognized as the holder of that security. Global securities will be registered in the name of the depositary or its participants. Consequently, for global securities, we will recognize only the depositary as the holder of the securities, and we will make all payments on the securities to the depositary. The depositary passes along the payments it receives to its participants, which in turn pass the payments along to their customers who are the beneficial owners. The depositary and its participants do so under agreements they have made with one another or with their customers; they are not obligated to do so under the terms of the securities.

As a result, investors in a global security will not own securities directly. Instead, they will own beneficial interests in a global security, through a bank, broker or other financial institution that participates in the depositary’s book-entry system or holds an interest through a participant. As long as the securities are issued in global form, investors will be indirect holders, and not legal holders, of the securities.

Street Name Holders

We may terminate a global security or issue securities in non-global form. In these cases, investors may choose to hold their securities in their own names or in “street name.” Securities held by an investor in street name would be registered in the name of a bank, broker or other financial institution that the investor chooses, and the investor would hold only a beneficial interest in those securities through an account he or she maintains at that institution.

For securities held in street name, we or any applicable trustee or depositary will recognize only the intermediary banks, brokers and other financial institutions in whose names the securities are registered as the holders of those securities, and we or any such trustee or depositary will make all payments on those securities to them. These institutions pass along the payments they receive to their customers who are the beneficial owners, but only because they agree to do so in their customer agreements or because they are legally required to do so. Investors who hold securities in street name will be indirect holders, not holders, of those securities.

Legal Holders

Our obligations, as well as the obligations of any applicable trustee or third party employed by us or a trustee, run only to the legal holders of the securities. We do not have obligations to investors who hold beneficial interests in global securities, in street name or by any other indirect means. This will be the case whether an investor chooses to be an indirect holder of a security or has no choice because we are issuing the securities only in global form.

For example, once we make a payment or give a notice to the legal holder, we have no further responsibility for the payment or notice even if that legal holder is required, under agreements with its participants or customers or by law, to pass it along to the indirect holders but does not do so. Similarly, we may want to obtain the approval of the holders to amend an indenture, to relieve us of the consequences of a default or of our obligation to comply with a particular provision of an indenture, or for other purposes. In such an event, we would seek approval only from the legal holders, and not the indirect holders, of the securities. Whether and how the legal holders contact the indirect holders is up to the legal holders.

Special Considerations for Indirect Holders

If you hold securities through a bank, broker or other financial institution, either in book-entry form because the securities are represented by one or more global securities or in street name, you should check with your own institution to find out:

- how it handles securities payments and notices;
- whether it imposes fees or charges;
- how it would handle a request for the holders' consent, if ever required;
- whether and how you can instruct it to send you securities registered in your own name so you can be a holder, if that is permitted in the future;
- how it would exercise rights under the securities if there were a default or other event triggering the need for holders to act to protect their interests; and
- if the securities are in book-entry form, how the depositary's rules and procedures will affect these matters.

Global Securities

A global security is a security that represents one or any other number of individual securities held by a depositary. Generally, all securities represented by the same global securities will have the same terms.

Each security issued in book-entry form will be represented by a global security that we issue to, deposit with and register in the name of a financial institution or its nominee that we select. The financial institution that we select for this purpose is called the depositary. Unless we specify otherwise in the applicable prospectus supplement, DTC will be the depositary for all securities issued in book-entry form.

A global security may not be transferred to or registered in the name of anyone other than the depositary, its nominee or a successor depositary, unless special termination situations arise. We describe those situations below under “—Special Situations When a Global Security Will Be Terminated.” As a result of these arrangements, the depositary, or its nominee, will be the sole registered owner and legal holder of all securities represented by a global security, and investors will be permitted to own only beneficial interests in a global security. Beneficial interests must be held by means of an account with a broker, bank or other financial institution that in turn has an account with the depositary or with another institution that does. Thus, an investor whose security is represented by a global security will not be a legal holder of the security, but only an indirect holder of a beneficial interest in the global security.

If the prospectus supplement for a particular security indicates that the security will be issued as a global security, then the security will be represented by a global security at all times unless and until the global security is terminated. If termination occurs, we may issue the securities through another book-entry clearing system or decide that the securities may no longer be held through any book-entry clearing system.

Special Considerations for Global Securities

As an indirect holder, an investor will have rights relating to a global security governed by the account rules of the investor's financial institution and of the depository, as well as general laws relating to securities transfers. We do not recognize an indirect holder as a holder of securities and instead deal only with the depository that holds the global security.

If securities are issued only as global securities, an investor should be aware of the following:

- an investor cannot cause the securities to be registered in his or her name, and cannot obtain non-global certificates for his or her interest in the securities, except in the special situations we describe below;
- an investor will be an indirect holder and must look to his or her own bank or broker for payments on the securities and protection of his or her legal rights relating to the securities, as we describe above;
- an investor may not be able to sell interests in the securities to some insurance companies and to other institutions that are required by law to own their securities in non-book-entry form;
- an investor may not be able to pledge his or her interest in the global security in circumstances where certificates representing the securities must be delivered to the lender or other beneficiary of the pledge in order for the pledge to be effective;
- the depository's policies, which may change from time to time, will govern payments, transfers, exchanges and other matters relating to an investor's interest in the global security;
- we and any applicable trustee have no responsibility for any aspect of the depository's actions or for its records of ownership interests in the global security, nor will we or any applicable trustee supervise the depository in any way;
- the depository may, and we understand that DTC will, require that those who purchase and sell interests in the global security within its book-entry system use immediately available funds, and your broker or bank may require you to do so as well; and
- financial institutions that participate in the depository's book-entry system, and through which an investor holds its interest in the global security, may also have their own policies affecting payments, notices and other matters relating to the securities.

There may be more than one financial intermediary in the chain of ownership for an investor. We do not monitor and are not responsible for the actions of any of those intermediaries.

Special Situations When a Global Security Will Be Terminated

In a few special situations described below, a global security will terminate and interests in it will be exchanged for physical certificates representing those interests. After that exchange, the choice of whether to hold securities directly or in street name will be up to the investor. Investors must consult their own banks or brokers to find out how to have their interests in securities transferred to their own names, so that they will be direct holders. We have described the rights of holders and street name investors above.

A global security will terminate when the following special situations occur:

- if the depository notifies us that it is unwilling, unable or no longer qualified to continue as depository for that global security and we do not appoint another institution to act as depository within 90 days;
- if we notify any applicable trustee that we wish to terminate that global security; or
- if an event of default has occurred with regard to securities represented by that global security and has not been cured or waived.

The applicable prospectus supplement may also list additional situations for terminating a global security that would apply only to the particular series of securities covered by the applicable prospectus supplement. When a global security terminates, the depositary, and neither we nor any applicable trustee, is responsible for deciding the names of the institutions that will be the initial direct holders.

PLAN OF DISTRIBUTION

We may sell the securities covered hereby from time to time pursuant to underwritten public offerings, direct sales to the public, negotiated transactions, block trades or a combination of these methods. A distribution of these securities offered by this prospectus may also be effected through the issuance of derivative securities, including without limitation, warrants. We may sell the securities to or through underwriters or dealers, through agents, or directly to one or more purchasers. We may distribute securities from time to time in one or more transactions:

- at a fixed price or prices, which may be changed;
- at market prices prevailing at the time of sale;
- at prices related to such prevailing market prices; or
- at negotiated prices.

We may also sell equity securities covered by this registration statement in an “at the market offering” as defined in Rule 415(a)(4) under the Securities Act. Such offering may be made into an existing trading market for such securities in transactions at other than a fixed price on or through the facilities of the Nasdaq Capital Market or any other securities exchange or quotation or trading service on which such securities may be listed, quoted or traded at the time of sale.

Such at-the-market offerings, if any, may be conducted by underwriters acting as principal or agent.

A prospectus supplement or supplements (and any related free writing prospectus that we may authorize to be provided to you) will describe the terms of the offering of the securities, including, to the extent applicable:

- the name or names of any underwriters, dealers or agents, if any;
- the purchase price of the securities and the proceeds we will receive from the sale;
- any options pursuant to which underwriters may purchase additional securities from us;
- any agency fees or underwriting discounts and other items constituting agents’ or underwriters’ compensation;
- any public offering price;
- any discounts or concessions allowed or reallocated or paid to dealers; and
- any securities exchange or market on which the securities may be listed.

Only underwriters named in the prospectus supplement are underwriters of the securities offered by the prospectus supplement.

If underwriters are used in the sale, they will acquire the securities for their own account and may resell the securities from time to time in one or more transactions at a fixed public offering price or at varying prices determined at the time of sale. The obligations of the underwriters to purchase the securities will be subject to the conditions set forth in the applicable underwriting agreement. We may offer the securities to the public through underwriting syndicates represented by managing underwriters or by underwriters without a syndicate. Subject to certain conditions, the underwriters will be obligated to purchase all of the securities offered by the prospectus supplement, other than securities covered by any option to purchase additional securities. Any public offering price and any discounts or concessions allowed or reallocated or paid to dealers may change from time to time. We may use underwriters with whom we have a material relationship. We will describe in the prospectus supplement, naming the underwriter, the nature of any such relationship.

We may sell securities directly or through agents we designate from time to time. We will name any agent involved in the offering and sale of securities, and we will describe any commissions and other compensation we will pay the

agent in the prospectus supplement. Unless the prospectus supplement states otherwise, our agent will act on a best-efforts basis for the period of its appointment.

We may authorize agents or underwriters to solicit offers by certain types of institutional investors to purchase securities from us at the public offering price set forth in the prospectus supplement pursuant to delayed delivery contracts providing for payment and delivery on a specified date in the future. We will describe the conditions to these contracts and the commissions we must pay for solicitation of these contracts in the prospectus supplement.

We may provide agents and underwriters with indemnification against civil liabilities related to this offering, including liabilities under the Securities Act, or contribution with respect to payments that the agents or underwriters may make with respect to these liabilities. Agents and underwriters may engage in transactions with, or perform services for, us in the ordinary course of business.

All securities we may offer, other than common stock, will be new issues of securities with no established trading market. Any agents or underwriters may make a market in these securities, but will not be obligated to do so and may discontinue any market making at any time without notice. We cannot guarantee the liquidity of the trading markets for any securities. There is currently no market for any of the offered securities, other than our common stock which is listed on the Nasdaq Capital Market. We have no current plans for listing of the preferred stock, debt securities or warrants on any securities exchange or quotation system; any such listing with respect to any particular preferred stock, debt securities or warrants will be described in the applicable prospectus supplement or other offering materials, as the case may be.

Any underwriter may engage in overallotment, stabilizing transactions, short covering transactions and penalty bids in accordance with Rule 103 of Regulation M under the Exchange Act. Overallotment involves sales in excess of the offering size, which create a short position. Stabilizing transactions permit bids to purchase the underlying security so long as the stabilizing bids do not exceed a specified maximum. Short covering transactions involve purchases of the securities in the open market after the distribution is completed to cover short positions. Penalty bids permit the underwriters to reclaim a selling concession from a dealer when the securities originally sold by the dealer are purchased in a stabilizing or covering transaction to cover short positions. Those activities may cause the price of the securities to be higher than it would otherwise be. If commenced, the underwriters may discontinue any of the activities at any time. These transactions may be effected on any exchange or over-the-counter market or otherwise.

Any agents and underwriters who are qualified market makers on the Nasdaq Capital Market may engage in passive market making transactions in the securities on the Nasdaq Capital Market in accordance with Rule 103 of Regulation M, during the business day prior to the pricing of the offering, before the commencement of offers or sales of the securities. Passive market makers must comply with applicable volume and price limitations and must be identified as passive market makers. In general, a passive market maker must display its bid at a price not in excess of the highest independent bid for such security; if all independent bids are lowered below the passive market maker's bid, however, the passive market maker's bid must then be lowered when certain purchase limits are exceeded. Passive market making may stabilize the market price of the securities at a level above that which might otherwise prevail in the open market and, if commenced, may be discontinued at any time.

LEGAL MATTERS

Unless otherwise indicated in the applicable prospectus supplement, certain legal matters in connection with the offering and the validity of the securities offered by this prospectus, and any supplement thereto, will be passed upon by Cooley LLP, New York, New York. Additional legal matters may be passed upon for us or any underwriters, dealers or agents, by counsel that we will name in the applicable prospectus supplement.

EXPERTS

The financial statements incorporated in this prospectus by reference to the Annual Report on Form 10-K for the year ended December 31, 2022 have been so incorporated in reliance on the report (which contains an explanatory paragraph relating to the Company's ability to continue as a going concern as described in Note 1 to the financial statements) of PricewaterhouseCoopers LLP, an independent registered public accounting firm, given on the authority of said firm as experts in auditing and accounting.

WHERE YOU CAN FIND MORE INFORMATION

This prospectus is part of a registration statement we filed with the SEC. This prospectus does not contain all of the information set forth in the registration statement and the exhibits to the registration statement. For further information with respect to us and the securities we are offering under this prospectus, we refer you to the registration statement and the exhibits and schedules filed as a part of the registration statement. You should rely only on the information contained in this prospectus or incorporated by reference in this prospectus. Neither we nor any agent, underwriter or dealer has authorized any person to provide you with different information. We are not making an offer of these securities in any state where the offer is not permitted. You should not assume that the information in this prospectus is accurate as of any date other than the date on the front page of this prospectus, regardless of the time of delivery of this prospectus or any sale of the securities offered by this prospectus.

We file annual, quarterly and current reports, proxy statements and other information with the SEC. Our SEC filings are available to the public over the Internet at the SEC's website at <http://www.sec.gov>.

Copies of certain information filed by us with the SEC are also available on our website at www.x4pharma.com. Information contained in or accessible through our website does not constitute a part of this prospectus and is not incorporated by reference into this prospectus.

INCORPORATION OF CERTAIN INFORMATION BY REFERENCE

The SEC allows us to “incorporate by reference” information that we file with it, which means that we can disclose important information to you by referring you to those documents. The information incorporated by reference is an important part of this prospectus. Information in this prospectus supersedes information incorporated by reference that we filed with the SEC prior to the date of this prospectus, while information that we file later with the SEC will automatically update and supersede the information in this prospectus. We also incorporate by reference into this prospectus the documents listed below and any future filings made by us with the SEC (other than Current Reports or portions thereof furnished under Item 2.02 or Item 7.01 of Form 8-K and exhibits filed on such form that are related to such items and other portions of documents that are furnished, but not filed, pursuant to applicable rules promulgated by the SEC) that are filed by us with the SEC pursuant to Sections 13(a), 13(c), 14 or 15(d) of the Exchange Act prior to the termination of this offering, including all such reports and documents filed with the SEC after the date of the initial filing of the registration statement of which this prospectus forms a part but prior to the effectiveness of such registration statement:

- Our Annual Report on Form 10-K for the fiscal year ended December 31, 2022, filed with the SEC on [March 21, 2023](#), including the information specifically incorporated by reference in the Annual Report on Form 10-K from our definitive proxy statement for the 2023 Annual Meeting of Stockholders, filed with the SEC on [April 25, 2023](#), as supplemented on [April 27, 2023](#);
- Our Quarterly Report on Form 10-Q for the fiscal quarter ended March 31, 2023, filed with the SEC on [May 4, 2023](#) and our Quarterly Report on Form 10-Q for the fiscal quarter ended June 30, 2023, filed with the SEC on [August 10, 2023](#);
- Our Current Reports on Form 8-K filed with the SEC on [January 6, 2023](#), [March 10, 2023](#), [May 16, 2023](#), [June 15, 2023](#), and [August 3, 2023](#) (in each case, except for information contained therein which is furnished rather than filed); and
- The description of our common stock set forth in the registration statement on [Form 8-A](#) registering our common stock under Section 12 of the Exchange Act, which was filed with the SEC on November 15, 2017, including any amendments or reports filed for purposes of updating such description, including [Exhibit 4.17](#) to our Annual Report on Form 10-K for the fiscal year ended December 31, 2022.

We will provide to each person, including any beneficial owner, to whom a prospectus is delivered, without charge upon written or oral request, a copy of any or all of the documents that are incorporated by reference into this prospectus but not delivered with the prospectus, including exhibits that are specifically incorporated by reference into such documents. You should direct any requests for documents to X4 Pharmaceuticals, Inc., Attn: Investor Relations, 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134.

Any statement contained herein or in a document incorporated or deemed to be incorporated by reference into this document will be deemed to be modified or superseded for purposes of the document to the extent that a statement contained in this document or any other subsequently filed document that is deemed to be incorporated by reference into this document modifies or supersedes the statement.



\$300,000,000

**Common Stock
Preferred Stock
Debt Securities
Warrants**

PROSPECTUS

, 2023

The information in this prospectus is not complete and may be changed. We may not sell these securities or accept an offer to buy these securities until the registration statement filed with the Securities and Exchange Commission is effective. This prospectus is not an offer to sell these securities, and it is not soliciting an offer to buy these securities in any jurisdiction where such offer or sale is not permitted.

SUBJECT TO COMPLETION, DATED AUGUST 11, 2023

PROSPECTUS



Up to \$75,000,000

Common Stock

This sales agreement prospectus relates to the issuance and sale of shares of our common stock having an aggregate offering price of up to \$75,000,000 from time to time through our sales agents, B. Riley Securities, Inc., Cantor Fitzgerald & Co., and Stifel, Nicolaus & Company, Incorporated, or, collectively, the Sales Agents. These sales, if any, will be made pursuant to the terms of the Controlled Equity OfferingSM Sales Agreement dated August 7, 2020, by and among us and the Sales Agents, or the Sales Agreement.

Our common stock is traded on the Nasdaq Capital Market under the symbol “XFOR.” On August 8, 2023, the closing sale price of our common stock on the Nasdaq Capital Market was \$1.69 per share.

Sales of shares of our common stock under this prospectus, if any, may be made by any method deemed to be an “at the market offering” as defined in Rule 415(a)(4) promulgated under the Securities Act of 1933, as amended, or the Securities Act. The Sales Agents are not required to sell any specific number or dollar amount of shares of our common stock. Each of the Sales Agents has agreed to use its commercially reasonable efforts to sell on our behalf all of the shares of common stock requested to be sold by us, consistent with its normal trading and sales practices, on mutually agreed terms among the Sales Agents and us. There is no arrangement for funds to be received in any escrow, trust or similar arrangement.

The Sales Agents will be entitled to compensation under the terms of the Sales Agreement at a commission rate of up to 3.0% of the gross sales price per share sold. In connection with the sale of common stock on our behalf, each of the Sales Agents will be deemed to be an “underwriter” within the meaning of the Securities Act, and the compensation of the Sales Agents will be deemed to be underwriting commissions or discounts. We have agreed to provide indemnification and contribution to the Sales Agents with respect to certain liabilities, including liabilities under the Securities Act.

Investing in our securities involves a high degree of risk. You should review carefully the risks and uncertainties described under the heading “[Risk Factors](#)” contained in this prospectus beginning on page S-4 and under similar headings in the other documents that are filed after the date hereof and incorporated by reference into this prospectus.

NEITHER THE SECURITIES AND EXCHANGE COMMISSION NOR ANY STATE SECURITIES COMMISSION HAS APPROVED OR DISAPPROVED OF THESE SECURITIES OR PASSED UPON THE ADEQUACY OF THIS PROSPECTUS. ANY REPRESENTATION TO THE CONTRARY IS A CRIMINAL OFFENSE.

B. Riley Securities

Cantor

Stifel

The date of this prospectus is , 2023

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ABOUT THIS PROSPECTUS

This prospectus is part of a shelf registration statement on Form S-3 that we filed with the SEC. Under this shelf registration process, we may offer shares of our common stock having an aggregate offering price of up to \$75,000,000 under this prospectus at prices and on terms to be determined by market conditions at the time of the offering.

This prospectus and the documents incorporated into this prospectus by reference include important information about us, the shares being offered and other information you should know before investing in our common stock. To the extent there is a conflict between the information contained in this prospectus, on the one hand, and the information contained in any document incorporated by reference into this prospectus that was filed with the SEC before the date of this prospectus, on the other hand, you should rely on the information in this prospectus. However, if any statement in one of these documents is inconsistent with a statement in another document having a later date—for example, a document incorporated by reference in this prospectus—the statement in the document having the later date modifies or supersedes the earlier statement.

We further note that the representations, warranties and covenants made by us in any agreement, including the Sales Agreement, that is filed as an exhibit to any document that is incorporated by reference herein were made solely for the benefit of the parties to such agreement, including, in some cases, for the purpose of allocating risk among the parties to such agreement, and should not be deemed to be a representation, warranty or covenant to you. Moreover, such representations, warranties or covenants were accurate only as of the date when made. Accordingly, such representations, warranties and covenants should not be relied on as accurately representing the current state of our affairs.

You should rely only on this prospectus and the information incorporated or deemed to be incorporated by reference into this prospectus. We have not, and the Sales Agents have not, authorized anyone to provide you with information that is in addition to or different from that contained or incorporated by reference into this prospectus. We and each of the Sales Agents take no responsibility for, and can provide no assurance as to the reliability of, any other information that others may give you. Neither we nor any of the Sales Agents are offering to sell these securities in any jurisdiction where the offer or sale is not permitted. You should not assume that the information contained or incorporated by reference in this prospectus is accurate as of any date other than as of the date of this prospectus or in the case of the documents incorporated by reference, the date of such documents regardless of the time of delivery of this prospectus or any sale of our common stock. Our business, financial conditions, liquidity, results of operations and prospects may have changed since those dates. You should read this prospectus, the documents incorporated by reference into this prospectus, and any free writing prospectus that we may authorize for use in connection with this offering, in their entirety before making an investment decision. You should also read and consider the information in the documents to which we have referred you in the sections of this prospectus titled “Where You Can Find More Information” and “Incorporation of Certain Information by Reference.”

We are offering to sell, and seeking offers to buy, shares of our common stock only in jurisdictions where such offers and sales are permitted. The distribution of this prospectus and the offering of our common stock in certain jurisdictions may be restricted by law. Persons outside the United States who come into possession of this prospectus must inform themselves about, and observe any restrictions relating to, the offering of our common stock and the distribution of this prospectus outside the United States. This prospectus does not constitute, and may not be used in connection with, an offer to sell, or a solicitation of an offer to buy, any securities offered by this prospectus by any person in any jurisdiction in which it is unlawful for such person to make such an offer or solicitation.

Unless otherwise indicated or the context otherwise requires, the terms “Company,” “X4 Pharmaceuticals,” “X4,” “Registrant,” “we,” “us” and “our” refer to X4 Pharmaceuticals, Inc., formerly Arsanis, Inc., and its subsidiaries.

PROSPECTUS SUMMARY

The following is a summary of information contained elsewhere in this prospectus or incorporated by reference into this prospectus. This summary is not complete and does not contain all of the information that you should consider before buying our securities. You should read this prospectus in its entirety, including the information incorporated by reference herein, before deciding to buy shares of our common stock.

Company 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. We are also currently advancing mavorixafor in clinical trial in people with certain chronic neutropenic disorders.

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.

Corporate Information

Prior to March 13, 2019, we were a clinical-stage biopharmaceutical company known as Arsanis, Inc. that had historically been focused on applying monoclonal antibody immunotherapies to address serious infectious diseases. Arsanis, Inc. was originally incorporated in the State of Delaware in August 2010.

On March 13, 2019, we completed our business combination with X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) in accordance with the terms of an Agreement and Plan of Merger, dated as of November 26, 2018, as amended on December 20, 2018 and March 8, 2019 (the “Merger Agreement”), that we entered into with X4 Therapeutics, Inc. and Artemis AC Corp., a Delaware corporation and our wholly owned subsidiary (the “Merger Sub”). Pursuant to the terms of the Merger Agreement, 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, which transaction we refer to as the Merger. At the closing of the Merger, we issued shares of our common stock to X4 Therapeutics, Inc. stockholders based on an agreed upon exchange ratio, and each option or warrant to purchase X4 Therapeutics, Inc. capital stock became an option or warrant, respectively, to purchase our common stock, subject to adjustment in accordance with the agreed upon exchange ratio. Following the closing of the Merger, we effected a 1-for-6 reverse stock split of our common stock, our name was changed to X4 Pharmaceuticals, Inc., the business of X4 Therapeutics, Inc. became our business, and we became a clinical-stage biopharmaceutical company focused on the discovery, development and commercialization of novel therapeutics for the treatment of rare diseases. In connection with the closing of the Merger, our stock began trading on the Nasdaq Capital Market under the symbol “XFOR” on March 14, 2019.

Our principal executive offices are located at 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134, and our telephone number is (857) 529-8300. Our website is located at <http://www.x4pharma.com>. We do not incorporate by reference into this prospectus the information on, or accessible through, our website, and you should not consider it as part of this prospectus.

THE OFFERING

Issuer	X4 Pharmaceuticals, Inc.
Common stock offered	Shares of our common stock having an aggregate offering price of up to \$75.0 million.
Common stock to be outstanding after this offering	Up to 44,378,698 shares, assuming a sales price of \$1.69 per share, which was the closing sale price of our common stock on the Nasdaq Capital Market on August 8, 2023. The actual number of shares issued will vary depending on the sales price under this offering.
Plan of Distribution	“At the market offering” that may be made from time to time through our Sales Agents. See “Plan of Distribution” beginning on page S-11 of this prospectus.
Use of Proceeds	We currently intend to use the net proceeds from this offering, if any, for general corporate purposes, which may include clinical trial and other research and development expenses, working capital, and general and administrative expenses. See “Use of Proceeds” beginning on page S-8 of this prospectus.
Risk Factors	Investment in our common stock involves substantial risks. You should read carefully the “Risk Factors” beginning on page S-4 of this prospectus and in documents incorporated by reference into this prospectus, including the risk factors incorporated by reference from our filings with the SEC.
Nasdaq Capital Market symbol	XFOR

The number of shares of our common stock to be outstanding after this offering set forth above is based on 164,418,011 shares of our common stock outstanding as of June 30, 2023 and excludes:

- 3,583,186 shares of our common stock issuable upon the exercise of options outstanding as of June 30, 2023, having a weighted average exercise price of \$4.47 per share;
- 5,859,232 shares of our common stock issuable upon the vesting and settlement of outstanding restricted stock unit awards, outstanding as of June 30, 2023, having a weighted average grant date fair value of \$1.40 per share;
- 32,414,134 shares of common stock issuable upon the exercise of pre-funded warrants, outstanding as of June 30, 2023, with 29,589,436 having an exercise price of \$0.001 per share and 2,824,698 having an exercise price of \$0.01 per share;
- 80,246,459 shares of our common stock issuable upon the exercise of warrants outstanding as of June 30, 2023, having a weighted average exercise price of \$1.88 per share; and
- 9,067,537 shares of common stock reserved for future issuance under our Amended and Restated 2017 Equity Incentive Plan, Amended and Restated 2017 Employee Stock Purchase Plan and 2019 Inducement Equity Incentive Plan as of June 30, 2023; and

- Up to \$50.0 million of our shares of common stock that may be sold from time to time under an equity line of credit arrangement that we entered into on January 14, 2022 with Lincoln Park Capital Fund, LLC, of which \$3.0 million of shares have been sold to date.

Except as otherwise indicated, all information in this prospectus assumes no exercise of the outstanding options or warrants referred to above, no vesting and settlement of the outstanding restricted stock units referred to above, and no sales pursuant to the Sales Agreement other than this offering.

RISK FACTORS

Investment in our securities involves risks. Prior to making a decision about investing in our securities, you should consider carefully all of the information included in and incorporated by reference or deemed to be incorporated by reference into this prospectus, including the risk factors incorporated by reference herein from our Quarterly Report on Form 10-Q for the quarter ended June 30, 2023, filed with the SEC on August 10, 2023, as updated by annual, quarterly and other reports and documents we file with the SEC after the date of this prospectus and that are incorporated by reference herein or in any free writing prospectus. Each of these risk factors could have a material adverse effect on our business, results of operations, financial position or cash flows, which may result in the loss of all or part of your investment. The risks and uncertainties we have described are not the only ones we face. Additional risks and uncertainties not presently known to us or that we currently consider immaterial may also impair our business operations. If any of these risks actually occur, our business and financial results could be harmed. In that case, the trading price of our common stock or other securities could decline. Please also read carefully the section below titled “Special Note Regarding Forward-Looking Statements.”

Risks Related to This Offering

Our management will have broad discretion as to the use of the proceeds from this offering and may not use the proceeds effectively.

Because we have not designated the amount of net proceeds to us from this offering to be used for any particular purpose, our management will have broad discretion as to the application of the net proceeds from this offering and could use them for purposes other than those contemplated at the time of the offering. Our management may use the net proceeds for corporate purposes that may not improve our financial condition or market value.

You may experience immediate and substantial dilution.

The offering price per share in this offering may exceed the net tangible book value per share of our common stock. Assuming that an aggregate of 44,378,698 shares of our common stock are sold at an assumed price of \$1.69 per share pursuant to this prospectus, which was the closing sale price of our common stock on the Nasdaq Capital Market on August 8, 2023, for aggregate net proceeds of approximately \$72.6 million, after deducting commissions and estimated aggregate offering expenses payable by us, you would experience immediate dilution of \$1.10 per share, representing a difference between our as adjusted net tangible book value per share as of June 30, 2023, after giving effect to this offering and the assumed offering price per share of common stock. To the extent that any options or warrants are exercised, any restricted stock units vest and are settled, any new equity awards are issued under our equity incentive plans, or we otherwise issue additional shares of common stock in the future (including shares issued in connection with strategic and other transactions), you will experience further dilution. In addition, we may choose to raise additional capital due to market conditions or strategic considerations, even if we believe we have sufficient funds for our current or future operating plans. To the extent that additional capital is raised through the sale of equity or convertible debt securities, the issuance of these securities could result in further dilution to our stockholders. See the section entitled “Dilution” on page S-9 of this prospectus for a more detailed illustration of the dilution you would incur if you participate in this offering.

Future sales of substantial amounts of our common stock, or the possibility that such sales could occur, could adversely affect the market price of our common stock.

We may issue up to \$75,000,000 of common stock from time to time in this offering. The issuance from time to time of shares in this offering, as well as our ability to issue such shares in this offering, could have the effect of depressing the market price or increasing the market price volatility of our common stock. See “Plan of Distribution” on page S-11 of this prospectus for more information about the possible adverse effects of our sales under the Sales Agreement.

You may experience future dilution as a result of future equity offerings.

In order to raise additional capital, we may in the future offer additional shares of our common stock or other securities convertible into or exchangeable for our common stock, which would result in dilution to all of our stockholders. In particular, at any time, including immediately following any placement of shares pursuant to this offering, we may sell additional equity or convertible debt securities, other than pursuant to this offering, in amounts that may be material to us, which may be in amounts that are equal to or greater than the size of this offering, including, without limitation, through underwritten public offerings, privately negotiated transactions, block trades, or any combination of the above, subject, in certain circumstances, to the consent of the Sales Agents. We cannot assure you that we will be able to sell shares or other securities in any other offering at a price per share that is equal to or greater than the price per share paid by investors in this offering, and investors purchasing shares or other securities in the future could have rights superior to existing stockholders. The price per share at which we sell additional shares of our common stock or other securities convertible into or exchangeable for our common stock in future transactions may be higher or lower than the price per share in this offering.

It is not possible to predict the actual number of shares we will sell under the Sales Agreement, or the gross proceeds resulting from those sales.

Subject to certain limitations in the Sales Agreement and compliance with applicable laws, we have the discretion to deliver a placement notice to the Sales Agents at any time throughout the term of the Sales Agreement. The number of shares that are sold through the Sales Agents after delivering a placement notice will fluctuate based on a number of factors, including the market price of our common stock during the term of the Sales Agreement, the limits we set with the Sales Agents in any applicable placement notice, and the demand for our common stock during the term of the Sales Agreement. Because the price per share of each share sold will fluctuate during the term of the Sales Agreement, it is not currently possible to predict the number of shares that will be sold or the gross proceeds to be raised in connection with the sales of shares of common stock offered under this prospectus.

The common stock offered hereby will be sold in “at the market offerings,” and investors who buy shares at different times will likely pay different prices.

Investors who purchase shares in this offering at different times will likely pay different prices, and so may experience different levels of dilution and different outcomes in their investment results. We will have discretion, subject to market demand, to vary the timing, prices and numbers of shares sold in this offering. In addition, there is no minimum or maximum sales price for shares to be sold in this offering. Investors may experience a decline in the value of the shares they purchase in this offering as a result of sales made at prices lower than the prices they paid.

Because we do not anticipate paying any cash dividends on our capital stock in the foreseeable future, capital appreciation, if any, will be your sole source of gain.

We have never paid or declared any cash dividends on our capital stock. We currently intend to retain earnings, if any, to finance the growth and development of our business and we do not anticipate paying any cash dividends in the foreseeable future. As a result, only appreciation of the price of our common stock will provide a return to our stockholders.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This prospectus and the documents incorporated by reference herein contain forward-looking statements. These are based on our management's current beliefs, expectations and assumptions about future events, conditions and results and on information currently available to us. Discussions containing these forward-looking statements may be found, among other places, in the sections entitled "Business," "Risk Factors" and "Management's Discussion and Analysis of Financial Condition and Results of Operations" contained in the documents incorporated by reference herein.

Any statements in this prospectus, or incorporated herein, about our expectations, beliefs, plans, objectives, assumptions or future events or performance are not historical facts and are forward-looking statements. Within the meaning of Section 27A of the Securities Act and Section 21E of the Securities Exchange Act of 1934, as amended, or the Exchange Act, these forward-looking statements include statements regarding:

- 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;
- the anticipated use of proceeds from this offering, if any;
- our strategies, prospects, plans, expectations or objectives; and
- other risks and uncertainties, including those listed under the caption “Risk Factors” in our most recent Annual Report on Form 10-K, our most recent Quarterly Report on Form 10-Q, and other filings we make with the SEC.

In some cases, you can identify forward-looking statements by the words “may,” “might,” “can,” “will,” “to be,” “could,” “would,” “should,” “expect,” “intend,” “plan,” “objective,” “anticipate,” “believe,” “estimate,” “predict,” “project,” “potential,” “likely,” “continue” and “ongoing,” or the negative of these terms, or other comparable terminology intended to identify statements about the future, although not all forward-looking statements contain these words. These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, levels of activity, performance or achievements to be materially different from the information expressed or implied by these forward-looking statements.

You should refer to the “Risk Factors” section of this prospectus and any related free writing prospectus, and under similar headings in the other documents that are incorporated by reference into this prospectus, 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. Given these risks, uncertainties and other factors, many of which are beyond our control, we cannot assure you that the forward-looking statements in this prospectus will prove to be accurate, and you should not place undue reliance on these forward-looking statements. 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.

Except as required by law, we assume no obligation to update these forward-looking statements publicly, or to revise any forward-looking statements to reflect events or developments occurring after the date of this prospectus, even if new information becomes available in the future.

USE OF PROCEEDS

The amount of proceeds from this offering will depend upon the number of shares of our common stock sold and the market price at which they are sold. There can be no assurance that we will be able to sell any shares under or fully utilize the Sales Agreement as a source of financing. Because there is no minimum offering amount required as a condition to close this offering, the actual total proceeds to us, if any, are not determinable at this time.

We intend to use any net proceeds from this offering for general corporate purposes. General corporate purposes may include research and development costs, including the conduct of one or more clinical trials and process development and manufacturing of our drug candidates, potential strategic acquisitions or licensing of complementary businesses, services or technologies, expansion of our technology infrastructure and capabilities, working capital, capital expenditures and other general corporate purposes. We may temporarily invest the net proceeds in a variety of capital preservation instruments, including investment grade, interest bearing instruments and U.S. government securities, until they are used for their stated purpose. We have not determined the amount of net proceeds to be used specifically for such purposes. As a result, management will retain broad discretion over the allocation of net proceeds.

Our expected use of the net proceeds from this offering represents our current intentions based upon our present plans and business conditions. The amounts and timing of our actual use of net proceeds will vary depending on numerous factors, including the relative success and cost of our research, preclinical and clinical development programs, whether we are able to enter into future collaborations, and any unforeseen delays or cash needs. As a result, our management will have broad discretion in the application of the net proceeds and investors will be relying on our judgment regarding the application of the net proceeds of this offering. In addition, we might decide to postpone or not pursue these planned trials and activities or other development activities if the net proceeds from this offering and the other sources of cash are less than, or do not last as long as, expected.

Pending use of the proceeds as described above, we intend to invest the proceeds in a variety of capital preservation investments, including short-term, interest-bearing instruments, investment-grade and U.S. government securities.

DILUTION

If you invest in our common stock, your ownership interest will be diluted to the extent of the difference between the public offering price per share of our common stock and the as-adjusted net tangible book value per share after this offering.

The net tangible book value of our common stock on June 30, 2023, was approximately \$50.2 million, or \$0.31 per share of common stock. We calculate net tangible book value per share by dividing the net tangible book value, which is tangible assets less total liabilities, by the number of outstanding shares of our common stock. Dilution with respect to net tangible book value per share represents the difference between the amount per share paid by purchasers of shares of common stock in this offering and the net tangible book value per share of our common stock immediately after this offering.

After giving effect to the sale of our common stock pursuant to this prospectus in the aggregate amount of \$75.0 million at an assumed offering price of \$1.69 per share, the closing sale price of our common stock on the Nasdaq Capital Market on August 8, 2023, and after deducting estimated offering commissions and estimated aggregate offering expenses payable by us, our as adjusted net tangible book value as of June 30, 2023 would have been approximately \$122.8 million, or \$0.59 per share of common stock. This would represent an immediate increase in the net tangible book value of \$0.28 per share to our existing stockholders and an immediate dilution in net tangible book value of \$1.10 per share to investors purchasing our common stock in this offering at the assumed public offering price. The following table illustrates this dilution on a per share basis:

Assumed public offering price per share		\$	1.69
Net tangible book value per share as of June 30, 2023		\$	0.31
Increase in net tangible book value per share attributable to this offering		\$	0.28
As adjusted net tangible book value per share as of June 30, 2023 after giving effect to this offering		\$	0.59
Dilution per share to investors purchasing in this offering		\$	1.10

The above discussion and table are based on 164,418,011 shares of our common stock outstanding as of June 30, 2023 and excludes the following:

- 3,583,186 shares of our common stock issuable upon the exercise of options outstanding as of June 30, 2023, having a weighted average exercise price of \$4.47 per share;
- 5,859,232 shares of our common stock issuable upon the vesting and settlement of outstanding restricted stock unit awards, outstanding as of June 30, 2023, having a weighted average grant date fair value of \$1.40 per share;
- 32,414,134 shares of common stock issuable upon the exercise of pre-funded warrants, outstanding as of June 30, 2023, with 29,589,436 having an exercise price of \$0.001 per share and 2,824,698 having an exercise price of \$0.01 per share;
- 80,246,459 shares of our common stock issuable upon the exercise of warrants outstanding as of June 30, 2023, having a weighted average exercise price of \$1.88 per share; and
- 9,067,537 shares of common stock reserved for future issuance under our Amended and Restated 2017 Equity Incentive Plan, Amended and Restated 2017 Employee Stock Purchase Plan and 2019 Inducement Equity Incentive Plan as of June 30, 2023; and

- Up to \$50.0 million of our shares of common stock that may be sold from time to time under an equity line of credit arrangement that we entered into on January 14, 2022 with Lincoln Park Capital Fund, LLC, of which \$3.0 million of shares have been sold to date.

The shares subject to the Sales Agreement with the Sales Agents are being sold from time to time at various prices. An increase of \$1.00 per share in the price at which the shares are sold from the assumed offering price of \$1.69 per share shown in the table above, assuming all of our common stock in the aggregate amount of \$75.0 million during the term of the Sales Agreement is sold at that price, would increase our pro forma as adjusted net tangible book value per share to \$0.64 per share and would decrease the dilution in net tangible book value per share to investors purchasing in this offering to \$1.05 per share, after deducting estimated offering commissions and estimated offering expenses payable by us. A decrease of \$1.00 per share in the price at which the shares are sold from the assumed offering price of \$1.69 per share shown in the table above, assuming all of our common stock in the aggregate amount of \$75.0 million during the term of the Sales Agreement is sold at that price, would decrease our pro forma as adjusted net tangible book value per share to \$0.45 per share and would increase the dilution in net tangible book value per share to investors purchasing in this offering to \$1.24 per share, after deducting estimated offering commissions and estimated offering expenses payable by us. This information is supplied for illustrative purposes only.

To the extent that any of these outstanding options or warrants are exercised or restricted stock units vest, or sales are made pursuant to the Sales Agreement, there will be further dilution to new investors. In addition, we may choose to raise additional capital due to market conditions or strategic considerations even if we believe we have sufficient funds for our current or future operating plans. To the extent that additional capital is raised through the sale of equity or convertible debt securities, the issuance of these securities may result in further dilution to our stockholders.

PLAN OF DISTRIBUTION

We previously entered into the Sales Agreement with the Sales Agents on August 7, 2020, under which we may offer and sell shares of our common stock from time to time through the Sales Agents, acting as agents. Pursuant to this prospectus, we may offer and sell up to \$75,000,000 of shares of our common stock from time to time through the Sales Agents. Sales of shares of our common stock, if any, under this prospectus may be made at market prices by any method deemed to be an “at the market offering” as defined in Rule 415(a)(4) under the Securities Act, including, without limitation, sales made directly on the Nasdaq Capital Market or any other existing trading market for our common stock.

We may instruct the Sales Agents not to sell our common stock if the sales cannot be effected at or above the price designated by us from time to time. We or the Sales Agents may suspend the offering of common stock upon notice and subject to other conditions.

We will pay the Sales Agents commissions, in cash, for their services for acting as a Sales Agent in the sale of our common stock. The Sales Agents will be entitled to compensation at a fixed commission rate of up to 3.0% of the gross sales price per share sold. In connection with the Sales Agreement, we agreed to reimburse the Sales Agents for certain specified expenses, including the fees and disbursements of their legal counsel, in an amount not to exceed \$50,000. We estimate that the total expenses for the offering, excluding compensation and reimbursement payable to the Sales Agents under the terms of the Sales Agreement, will be approximately \$134,000. Because there is no minimum offering amount required as a condition to close this offering, the actual total public offering amount, commissions and proceeds to us, if any, are not determinable at this time.

Settlement for sales of our common stock will occur on the second trading day following the date on which any sales are made, or on some other date that is agreed upon by us and the Sales Agents in connection with a particular transaction, in return for payment of the net proceeds to us. Sales of our common stock as contemplated in this prospectus will be settled through the facilities of The Depository Trust Company or by such other means as we and the Sales Agents may agree upon. There is no arrangement for funds to be received in an escrow, trust or similar arrangement.

The Sales Agents will use their commercially reasonable efforts, consistent with their sales and trading practice, to solicit offers to purchase shares of our common stock under the terms and subject to the conditions set forth in the Sales Agreement. In connection with the sale of shares of our common stock on our behalf, each of the Sales Agents will be deemed to be an “underwriter” within the meaning of the Securities Act and the compensation of the Sales Agents will be deemed to be underwriting commissions or discounts. We have agreed to provide indemnification and contribution to the Sales Agents against certain civil liabilities, including liabilities under the Securities Act.

The offering pursuant to the Sales Agreement will terminate upon the termination of the Sales Agreement as permitted therein. We and the Sales Agents may each terminate the Sales Agreement at any time upon ten days’ prior notice.

The Sales Agents and their affiliates may provide various investment banking and other financial services for us and our affiliates, for which services they may in the future receive customary fees. To the extent required by Regulation M, the Sales Agents will not engage in any market making activities involving our common stock while the offering is ongoing under this prospectus.

This summary of the material provisions of the Sales Agreement does not purport to be a complete statement of its terms and conditions. A copy of the Sales Agreement is filed as an exhibit to the Registration Statement of which this prospectus forms a part and is incorporated by reference in this prospectus. This prospectus in electronic format may be made available on a website maintained by each of the Sales Agents and the Sales Agents may distribute this prospectus electronically.

LEGAL MATTERS

The validity of the securities being offered hereby will be passed on by Cooley LLP, New York, New York. The Sales Agents are being represented in connection with this offering by Paul Hastings LLP, New York, New York.

EXPERTS

The financial statements incorporated in this prospectus by reference to the Annual Report on Form 10-K for the year ended December 31, 2022 have been so incorporated in reliance on the report (which contains an explanatory paragraph relating to the Company's ability to continue as a going concern as described in Note 1 to the financial statements) of PricewaterhouseCoopers LLP, an independent registered public accounting firm, given on the authority of said firm as experts in auditing and accounting.

WHERE YOU CAN FIND MORE INFORMATION

This prospectus is part of a registration statement we filed with the SEC. This prospectus does not contain all of the information set forth in the registration statement and the exhibits to the registration statement. For further information with respect to us and the securities we are offering under this prospectus, we refer you to the registration statement and the exhibits and schedules filed as a part of the registration statement. You should rely only on the information contained in this prospectus or incorporated by reference in this prospectus. Neither we nor any agent, underwriter or dealer has authorized any person to provide you with different information. We are not making an offer of these securities in any state where the offer is not permitted. You should not assume that the information in this prospectus is accurate as of any date other than the date on the front page of this prospectus, regardless of the time of delivery of this prospectus or any sale of the securities offered by this prospectus.

We file annual, quarterly and current reports, proxy statements and other information with the SEC. Our SEC filings are available to the public over the Internet at the SEC's website at <http://www.sec.gov>.

Copies of certain information filed by us with the SEC are also available on our website at www.x4pharma.com. Information contained in or accessible through our website does not constitute a part of this prospectus and is not incorporated by reference into this prospectus.

INCORPORATION OF CERTAIN INFORMATION BY REFERENCE

The SEC allows us to “incorporate by reference” information that we file with it, which means that we can disclose important information to you by referring you to those documents. The information incorporated by reference is an important part of this prospectus. Information in this prospectus supersedes information incorporated by reference that we filed with the SEC prior to the date of this prospectus, while information that we file later with the SEC will automatically update and supersede the information in this prospectus. We also incorporate by reference into this prospectus the documents listed below and any future filings made by us with the SEC (other than Current Reports or portions thereof furnished under Item 2.02 or Item 7.01 of Form 8-K and exhibits filed on such form that are related to such items and other portions of documents that are furnished, but not filed, pursuant to applicable rules promulgated by the SEC) that are filed by us with the SEC pursuant to Sections 13(a), 13(c), 14 or 15(d) of the Exchange Act prior to the termination of this offering, including all such reports and documents filed with the SEC after the date of the initial filing of the registration statement of which this prospectus forms a part but prior to the effectiveness of such registration statement:

- Our Annual Report on Form 10-K for the fiscal year ended December 31, 2022, filed with the SEC on [March 21, 2023](#), including the information specifically incorporated by reference in the Annual Report on Form 10-K from our definitive proxy statement for the 2023 Annual Meeting of Stockholders, filed with the SEC on [April 25, 2023](#), as supplemented on [April 27, 2023](#);
- Our Quarterly Report on Form 10-Q for the fiscal quarter ended March 31, 2023, filed with the SEC on [May 4, 2023](#) and our Quarterly Report on Form 10-Q for the fiscal quarter ended June 30, 2023, filed with the SEC on [August 10, 2023](#);
- Our Current Reports on Form 8-K filed with the SEC on [January 6, 2023](#), [March 10, 2023](#), [May 16, 2023](#), [June 15, 2023](#) and [August 3, 2023](#) (in each case, except for information contained therein which is furnished rather than filed); and
- The description of our common stock set forth in the registration statement on [Form 8-A](#) registering our common stock under Section 12 of the Exchange Act, which was filed with the SEC on November 15, 2017, including any amendments or reports filed for purposes of updating such description, including [Exhibit 4.17](#) to our Annual Report on Form 10-K for the fiscal year ended December 31, 2022.

We will provide to each person, including any beneficial owner, to whom a prospectus is delivered, without charge upon written or oral request, a copy of any or all of the documents that are incorporated by reference into this prospectus but not delivered with the prospectus, including exhibits that are specifically incorporated by reference into such documents. You should direct any requests for documents to X4 Pharmaceuticals, Inc., Attn: Investor Relations, 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134.

Any statement contained herein or in a document incorporated or deemed to be incorporated by reference into this document will be deemed to be modified or superseded for purposes of the document to the extent that a statement contained in this document or any other subsequently filed document that is deemed to be incorporated by reference into this document modifies or supersedes the statement.



Up to \$75,000,000

Common Stock

PROSPECTUS

**B.Riley Securities
Cantor
Stifel**

, 2023

The information in this prospectus is not complete and may be changed. We may not sell these securities or accept an offer to buy these securities until the registration statement filed with the Securities and Exchange Commission is effective. This prospectus is not an offer to sell these securities, and it is not soliciting an offer to buy these securities in any jurisdiction where such offer or sale is not permitted.

SUBJECT TO COMPLETION, DATED AUGUST 11, 2023

PROSPECTUS



\$50,000,000 and

230,414 Shares of Common Stock

This purchase agreement prospectus relates to the issuance and sale of up to \$50,000,000 of shares of our common stock, par value \$0.001 per share, or the Purchase Shares, that we may sell to Lincoln Park Capital Fund, LLC, or Lincoln Park, from time to time pursuant to the purchase agreement dated January 14, 2022, or the Purchase Agreement, that we have entered into with Lincoln Park.

On January 14, 2022, the commencement date of the Purchase Agreement, we issued to Lincoln Park (i) as an initial purchase under the Purchase Agreement, 1,382,488 shares of common stock, at a per share price of \$2.17 per share, for aggregate consideration of approximately \$3,000,000, or the Initial Purchase Shares, and (ii) as consideration for Lincoln Park's commitment to purchase shares of our common stock under the Purchase Agreement, 230,414 shares of our common stock, or the Commitment Shares.

In addition to the issuance and sale of the Purchase Shares from time to time, this purchase agreement prospectus also covers the resale of the Initial Purchase Shares and Commitment Shares by Lincoln Park to the public. We will not receive any proceeds from the resale of these shares. See "Lincoln Park Transaction" for a description of the Purchase Agreement and additional information regarding Lincoln Park. Lincoln Park is an "underwriter" within the meaning of Section 2(a)(11) of the Securities Act of 1933, as amended, or the Securities Act.

The purchase price for the Purchase Shares, other than the 1,382,488 Initial Purchase Shares sold to Lincoln Park at a per share price of \$2.17 per share, will be based upon formulas set forth in the Purchase Agreement depending on the type of purchase notice we submit to Lincoln Park from time to time. We will pay the expenses incurred in connection with the issuance of the shares of our common stock, including legal and accounting fees. See "Plan of Distribution."

Our common stock is traded on the Nasdaq Capital Market under the symbol "XFOR." On August 8, 2023, the closing sale price of our common stock on the Nasdaq Capital Market was \$1.69 per share.

Investing in our securities involves a high degree of risk. You should review carefully the risks and uncertainties described under the heading "[Risk Factors](#)" contained in this prospectus beginning on page S-5 and under similar headings in the other documents that are filed after the date hereof and incorporated by reference into this prospectus.

NEITHER THE SECURITIES AND EXCHANGE COMMISSION NOR ANY STATE SECURITIES COMMISSION HAS APPROVED OR DISAPPROVED OF THESE SECURITIES OR PASSED UPON THE ADEQUACY OF THIS PROSPECTUS. ANY REPRESENTATION TO THE CONTRARY IS A CRIMINAL OFFENSE.

The date of this prospectus is , 2023.

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ABOUT THIS PROSPECTUS

This prospectus and the documents incorporated into this prospectus by reference include important information about us, the shares being offered and other information you should know before investing in our common stock. To the extent there is a conflict between the information contained in this prospectus, on the one hand, and the information contained in any document incorporated by reference into this prospectus that was filed with the Securities and Exchange Commission, or SEC, before the date of this prospectus, on the other hand, you should rely on the information in this prospectus. However, if any statement in one of these documents is inconsistent with a statement in another document having a later date—for example, a document incorporated by reference in this prospectus—the statement in the document having the later date modifies or supersedes the earlier statement as our business, financial condition, results of operations and prospects may have changed since the earlier dates.

We further note that the representations, warranties and covenants made by us in any agreement, including the Purchase Agreement, that is filed as an exhibit to any document that is incorporated by reference herein were made solely for the benefit of the parties to such agreement, including, in some cases, for the purpose of allocating risk among the parties to such agreement, and should not be deemed to be a representation, warranty or covenant to you. Moreover, such representations, warranties or covenants were accurate only as of the date when made. Accordingly, such representations, warranties and covenants should not be relied on as accurately representing the current state of our affairs.

You should rely only on this prospectus and the information incorporated or deemed to be incorporated by reference into this prospectus. Neither we nor Lincoln Park have authorized anyone to provide you with information that is in addition to or different from that contained or incorporated by reference into this prospectus. We take no responsibility for, and can provide no assurance as to the reliability of, any other information that others may give you. We are not, and Lincoln Park is not, offering to sell these securities in any jurisdiction where the offer or sale is not permitted. You should not assume that the information contained or incorporated by reference in this prospectus is accurate as of any date other than as of the date of this prospectus or, in the case of the documents incorporated by reference, the date of such documents regardless of the time of delivery of this prospectus or any sale of our common stock. Our business, financial conditions, liquidity, results of operations and prospects may have changed since those dates. You should read this prospectus, the documents incorporated by reference into this prospectus, and any free writing prospectus that we may authorize for use in connection with this offering, in their entirety before making an investment decision. You should also read and consider the information in the documents to which we have referred you in the sections of this prospectus titled “Where You Can Find More Information” and “Incorporation of Certain Information by Reference.”

Unless otherwise indicated or the context otherwise requires, the terms “Company,” “X4 Pharmaceuticals,” “X4,” “Registrant,” “we,” “us” and “our” refer to X4 Pharmaceuticals, Inc., formerly Arsanis, Inc., and its subsidiaries.

PROSPECTUS SUMMARY

The following is a summary of selected information contained elsewhere in this prospectus or incorporated by reference into this prospectus. It does not contain all of the information that you should consider before buying our securities. You should read this prospectus in its entirety, including the information incorporated by reference herein and therein, before deciding to buy shares of our common stock.

Business Overview of X4 Pharmaceuticals, Inc.

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. We are also currently advancing mavorixafor in clinical trial in people with certain chronic neutropenic disorders.

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.

You can find more information about us in our filings with the SEC referenced in the sections in this document titled “Where You Can Find More Information” and “Incorporation of Certain Information by Reference.”

Prior to March 13, 2019, we were a clinical-stage biopharmaceutical company known as Arsanis, Inc. that had historically been focused on applying monoclonal antibody immunotherapies to address serious infectious diseases. Arsanis, Inc. was originally incorporated in the State of Delaware in August 2010.

On March 13, 2019, we completed our business combination with X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) in accordance with the terms of an Agreement and Plan of Merger, dated as of November 26, 2018, as amended on December 20, 2018 and March 8, 2019 (the “Merger Agreement”), that we entered into with X4 Therapeutics, Inc. and Artemis AC Corp., a Delaware corporation and our wholly owned subsidiary, or the Merger Sub. Pursuant to the terms of the Merger Agreement, 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, which transaction we refer to as the Merger. At the closing of the Merger, we issued shares of our common stock to X4 Therapeutics, Inc. stockholders based on an agreed upon exchange ratio, and each option or warrant to purchase X4 Therapeutics, Inc. capital stock became an option or warrant, respectively, to purchase our common stock, subject to adjustment in accordance with the agreed upon exchange ratio. Following the closing of the Merger, we effected a 1-for-6 reverse stock split of our common stock, our name was changed to X4 Pharmaceuticals, Inc., the business of X4 Therapeutics, Inc. became our business, and we became a clinical-stage biopharmaceutical company focused on the discovery, development and commercialization of novel therapeutics for the treatment of rare diseases. In connection with the closing of the Merger, our stock began trading on the Nasdaq Capital Market under the symbol “XFOR” on March 14, 2019.

Our principal executive offices are located at 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134, and our telephone number is (857) 529-8300. Our website is located at <http://www.x4pharma.com>. We do not

incorporate by reference into this prospectus the information on, or accessible through, our website, and you should not consider it as part of this prospectus.

THE OFFERING

Issuer	X4 Pharmaceuticals, Inc.
Common Stock Offered By Us	<ul style="list-style-type: none">• 230,414 Commitment Shares issued to Lincoln Park as consideration for its commitment to purchase shares of our common stock under the Purchase Agreement. We have not and will not receive any cash proceeds from the issuance of these Commitment Shares.• Up to \$50,000,000 of shares of our common stock we may sell to Lincoln Park from time to time prior to February 1, 2025, at our sole discretion, in accordance with the Purchase Agreement. On January 14, 2022, the commencement date of the Purchase Agreement, we sold to Lincoln Park 1,382,488 Initial Purchase Shares at a price of \$2.17 per share, for aggregate consideration of approximately \$3,000,000, as an initial purchase under the Purchase Agreement.
Common Stock to be Outstanding After the Offering	29,423,552 shares, which includes 1,382,488 Initial Purchase Shares and 230,414 Commitment Shares and assumes the sale of 27,810,650 shares at a price of \$1.69 per share, which was the closing sale price of our common stock on the Nasdaq Capital Market on August 8, 2023, for the \$47,000,000 of additional shares of our Common Stock we may sell to Lincoln Park from time to time. The actual number of shares issued will vary depending on the sales prices under this offering, but will not be greater than 5,622,718 shares, representing 19.99% of the shares of our common stock outstanding on the date of the Purchase Agreement, unless, in accordance with Nasdaq Market rules, we obtain stockholder approval of the issuance of shares of our common stock under the Purchase Agreement in excess of the Exchange Cap (as defined therein), or the average price of all applicable sales of our common stock to Lincoln Park under the Purchase Agreement is equal to or greater than the \$2.17 Minimum Price.
Use of Proceeds	We intend to use the net proceeds from this offering, if any, to develop our product pipeline, for working capital and for general corporate purposes. See “Use of Proceeds” beginning on page S-10 of this prospectus.
Risk Factors	Investment in our common stock involves substantial risks. You should read carefully the “Risk Factors” beginning on page S-5 of this prospectus and in documents incorporated by reference into this prospectus, including the risk factors incorporated by reference from our filings with the SEC.
Nasdaq Capital Market Symbol	XFOR

The number of shares of our common stock to be outstanding after this offering set forth above is based on 164,418,011 shares of our common stock outstanding as of June 30, 2023 and excludes:

- 3,583,186 shares of our common stock issuable upon the exercise of options outstanding as of June 30, 2023, having a weighted average exercise price of \$4.47 per share;
- 5,859,232 shares of our common stock issuable upon the vesting and settlement of outstanding restricted stock unit awards, outstanding as of June 30, 2023, having a weighted average grant date fair value of \$1.40 per share;

- 32,414,134 shares of common stock issuable upon the exercise of pre-funded warrants, outstanding as of June 30, 2023, with 29,589,436 having an exercise price of \$0.001 per share and 2,824,698 having an exercise price of \$0.01 per share;
- 80,246,459 shares of our common stock issuable upon the exercise of warrants outstanding as of June 30, 2023, having a weighted average exercise price of \$1.88 per share;
- 9,067,537 shares of common stock reserved for future issuance under our Amended and Restated 2017 Equity Incentive Plan, Amended and Restated 2017 Employee Stock Purchase Plan and 2019 Inducement Equity Incentive Plan as of June 30, 2023; and
- Up to \$75.0 million of our shares of common stock that may be sold from time to time under an “at the market” equity offering program that we entered into on August 7, 2020 with B. Riley Securities, Inc., Cantor Fitzgerald & Co. and Stifel, Nicolaus & Company, Incorporated, of which approximately \$15.0 million have been sold to date.

Except as otherwise indicated, all information in this prospectus assumes no exercise of the outstanding options or warrants referred to above, and no vesting and settlement of the outstanding restricted stock units referred to above.

RISK FACTORS

Investment in our securities involves risks. Prior to making a decision about investing in our securities, you should consider carefully all of the information included in and incorporated by reference or deemed to be incorporated by reference into this prospectus, including the risk factors incorporated by reference herein from our Quarterly Report on Form 10-Q for the quarter ended June 30, 2023, filed with the SEC on August 10, 2023, as updated by annual, quarterly and other reports and documents we file with the SEC after the date of this prospectus and that are incorporated by reference herein or in any free writing prospectus. Each of these risk factors could have a material adverse effect on our business, results of operations, financial position or cash flows, which may result in the loss of all or part of your investment. The risks and uncertainties we have described are not the only ones we face. Additional risks and uncertainties not presently known to us or that we currently consider immaterial may also impair our business operations. If any of these risks actually occur, our business and financial results could be harmed. In that case, the trading price of our common stock or other securities could decline. Please also read carefully the section below titled “Special Note Regarding Forward-Looking Statements.”

Risks Related to This Offering and Our Securities

The sale or issuance of our common stock to Lincoln Park may cause dilution, and the sale of the shares of common stock acquired by Lincoln Park, or the perception that such sales may occur, could cause the price of our common stock to fall.

On January 14, 2022, we entered into the Purchase Agreement with Lincoln Park, pursuant to which Lincoln Park has committed to purchase up to \$50,000,000 of our common stock. As of the date of this prospectus, we have sold to Lincoln Park, as an initial purchase under the Purchase Agreement, 1,382,488 shares of common stock, at a per share price of \$2.17 per share, for aggregate consideration of approximately \$3,000,000, and we have issued to Lincoln Park the 230,414 Commitment Shares. The remaining shares of our common stock that may be issued under the Purchase Agreement may be sold by us to Lincoln Park at our discretion from time to time prior to February 1, 2025 after the satisfaction of certain conditions set forth in the Purchase Agreement, including that the registration statement that includes this prospectus is effective. The purchase price for the shares that we may sell to Lincoln Park under the Purchase Agreement will fluctuate based on the price of our common stock. Depending on market liquidity at the time, sales of such shares may cause the trading price of our common stock to fall.

We generally have the right to control the timing and amount of any future sales of our shares to Lincoln Park. Additional sales of our common stock, if any, to Lincoln Park will depend upon market conditions and other factors to be determined by us. We may ultimately decide to sell to Lincoln Park all, some or none of the additional shares of our common stock that may be available for us to sell pursuant to the Purchase Agreement. If and when we do sell shares to Lincoln Park, after Lincoln Park has acquired the shares, Lincoln Park may resell all, some or none of those shares at any time or from time to time in its discretion. Therefore, sales to Lincoln Park by us could result in substantial dilution to the interests of other holders of our common stock. Additionally, the sale of a substantial number of shares of our common stock to Lincoln Park, or the anticipation of such sales, could make it more difficult for us to sell equity or equity-related securities in the future at a time and at a price that we might otherwise wish to effect sales.

We may not be able to access sufficient funds under the Purchase Agreement when needed.

Our ability to sell shares to Lincoln Park and obtain funds under the Purchase Agreement is limited by the terms and conditions in the Purchase Agreement, including restrictions on the amounts we may sell to Lincoln Park at any one time, and a limitation on our ability to sell shares to Lincoln Park to the extent that it would cause Lincoln Park to beneficially own more than 9.99% of our outstanding shares of common stock. Additionally, under the Purchase Agreement, we will only be able to sell or issue to Lincoln Park a maximum aggregate number of shares equal to the Exchange Cap of 19.99% of the shares of common stock outstanding on the date of the Purchase Agreement, unless we obtain shareholder approval to issue shares in excess of the Exchange Cap, or unless the average price of all applicable sales of our common stock to Lincoln Park under the Purchase Agreement is equal to or greater than the Minimum Price of \$2.17, such that the Exchange Cap would not apply to issuances and sales of common stock to

Lincoln Park under the Purchase Agreement. Therefore, we currently do not, and may not in the future, have access to the full amount otherwise available to us under the Purchase Agreement. In addition, any amounts we sell under the Purchase Agreement may not satisfy all of our funding needs, even if we are able and choose to sell and issue all of our common stock otherwise issuable pursuant to the Purchase Agreement.

We will require additional financing to sustain our operations, without which we may not be able to continue operations, and the terms of subsequent financings may adversely impact our stockholders.

We may direct Lincoln Park to purchase up to an additional \$47,000,000 worth of shares of our common stock under our agreement from time to time prior to February 1, 2025, generally in a “regular purchase,” in amounts up to 50,000 shares of our common stock, which may be increased to up to 100,000 shares of our common stock depending on the market price of our common stock at the time of sale, and, in each case, subject to a maximum limit of \$2,000,000 per purchase, on any single business day (such share amounts being subject to adjustment for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction as provided in the Purchase Agreement).

The extent to which we rely on Lincoln Park as a source of funding will depend on a number of factors including the prevailing market price of our common stock and the extent to which we are able to secure working capital from other sources. If obtaining sufficient funding from Lincoln Park were to prove unavailable or prohibitively dilutive, we will need to secure another source of funding in order to satisfy our working capital needs. Even if we sell all of the additional \$47,000,000 of our common stock to Lincoln Park under the Purchase Agreement, we will still need additional capital to finance our future clinical development plans and working capital needs, and we may have to raise funds through the issuance of equity or debt securities. Depending on the type and the terms of any financing we pursue, stockholders’ rights and the value of their investment in our common stock could be reduced. A financing could involve one or more types of securities including common stock, convertible debt or warrants to acquire common stock. These securities could be issued at or below the then prevailing market price for our common stock. In addition, if we issue secured debt securities, the holders of the debt would have a claim to our assets that would be prior to the rights of stockholders until the debt is paid. Interest on these debt securities would increase costs and negatively impact operating results. If the issuance of new securities results in diminished rights to holders of our common stock, the market price of our common stock could be negatively impacted. Should the financing we require to sustain our clinical development and working capital needs be unavailable or prohibitively expensive when we require it, the consequences could be a material adverse effect on our business, operating results, financial condition and prospects.

Sales of a substantial number of shares of our common stock in the public market or raising additional funds through debt or equity financing could cause our stock price to fall.

To the extent that we raise additional capital through the sale of equity or convertible debt securities, your ownership interest may be diluted, and the terms of these securities may include liquidation or other preferences that adversely affect your rights as a stockholder. Debt financing, if available, may involve agreements that include covenants limiting or restricting our ability to take certain actions, such as incurring debt, making capital expenditures or declaring dividends. If we raise additional funds through collaborations, strategic collaborations or partnerships, or marketing, distribution or licensing arrangements with third parties, we may be required to limit valuable rights to our intellectual property, technologies, therapeutic candidates or future revenue streams, or grant licenses or other rights on terms that are not favorable to us. Furthermore, any additional fundraising efforts may divert our management from their day-to-day activities, which may adversely affect our ability to develop and commercialize our therapeutic candidates.

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 may have on the prevailing market price of our common stock. A substantial number of shares of common stock are being offered by this prospectus, and we cannot predict if and when Lincoln Park may sell such shares in the public markets. We

cannot predict the number of these shares that might be sold nor the effect that future sales of the shares of our common stock would have on the market price of our common stock.

Our management will have broad discretion as to the use of the proceeds from this offering and may not use the proceeds effectively.

Because we have not designated the amount of net proceeds from this offering to be used for any particular purpose, our management will have broad discretion as to the application of the net proceeds from this offering and could use them for purposes other than those contemplated at the time of the offering. Our management may use the net proceeds for corporate purposes that may not improve our financial condition or market value.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This prospectus and the documents incorporated by reference herein contain forward-looking statements. These are based on our management's current beliefs, expectations and assumptions about future events, conditions and results and on information currently available to us. Discussions containing these forward-looking statements may be found, among other places, in the sections entitled "Business," "Risk Factors" and "Management's Discussion and Analysis of Financial Condition and Results of Operations" contained in the documents incorporated by reference herein.

Any statements in this prospectus, or incorporated herein, about our expectations, beliefs, plans, objectives, assumptions or future events or performance are not historical facts and are forward-looking statements. Within the meaning of Section 27A of the Securities Act and Section 21E of the Securities Exchange Act of 1934, as amended, or the Exchange Act, these forward-looking statements include statements regarding:

- 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;
- the anticipated use of proceeds from this offering, if any;
- our strategies, prospects, plans, expectations or objectives; and
- other risks and uncertainties, including those listed under the caption “Risk Factors” in our most recent Annual Report on Form 10-K, our most recent Quarterly Report on Form 10-Q, and other filings we make with the SEC.

In some cases, you can identify forward-looking statements by the words “may,” “might,” “can,” “will,” “to be,” “could,” “would,” “should,” “expect,” “intend,” “plan,” “objective,” “anticipate,” “believe,” “estimate,” “predict,” “project,” “potential,” “likely,” “continue” and “ongoing,” or the negative of these terms, or other comparable terminology intended to identify statements about the future, although not all forward-looking statements contain these words. These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, levels of activity, performance or achievements to be materially different from the information expressed or implied by these forward-looking statements.

You should refer to the “Risk Factors” section of this prospectus and any related free writing prospectus, and under similar headings in the other documents that are incorporated by reference into this prospectus, 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. Given these risks, uncertainties and other factors, many of which are beyond our control, we cannot assure you that the forward-looking statements in this prospectus will prove to be accurate, and you should not place undue reliance on these forward-looking statements. 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.

Except as required by law, we assume no obligation to update these forward-looking statements publicly, or to revise any forward-looking statements to reflect events or developments occurring after the date of this prospectus, even if new information becomes available in the future.

USE OF PROCEEDS

We received approximately \$3,000,000 in gross proceeds from the initial sale of 1,382,488 shares of our common stock pursuant to the Purchase Agreement, and we may receive up to an additional \$47,000,000 in aggregate gross proceeds from any sales we make to Lincoln Park pursuant to the Purchase Agreement from and after the date of this prospectus. We may sell fewer than all of the shares offered by this prospectus, in which case our offering proceeds will be less. Because we are not obligated to sell any additional shares of our common stock under the Purchase Agreement, the actual total offering amount and proceeds to us, if any, are not determinable at this time. See “Plan of Distribution” elsewhere in this prospectus for more information.

We intend to use the net proceeds, if any, from this offering to develop our product pipeline, for working capital and for general corporate purposes. We have not determined the amount of net proceeds to be used specifically for such purposes. As a result, management will retain broad discretion over the allocation of net proceeds.

The amounts and timing of our actual expenditures will depend on numerous factors, including our development and commercialization efforts, as well as the amount of cash used in our operations. We therefore cannot estimate with certainty the amount of net proceeds to be used for the purposes described above. We may find it necessary or advisable to use the net proceeds for other purposes, and we will have broad discretion in the application of the net proceeds. Pending the uses described above, we plan to invest the net proceeds from this offering in short-term, investment-grade, interest-bearing securities.

DILUTION

The net tangible book value of our common stock on June 30, 2023, was approximately \$50.2 million, or \$0.31 per share of common stock. We calculate net tangible book value per share by dividing the net tangible book value, which is tangible assets less total liabilities, by the number of outstanding shares of our common stock. Dilution with respect to net tangible book value per share represents the difference between the amount per share paid by purchasers of shares of common stock in this offering and the net tangible book value per share of our common stock immediately after this offering.

After giving effect to the assumed sale by us of 27,810,650 shares of our common stock under this prospectus (which excludes the 1,382,488 Initial Purchase Shares and the 230,414 Commitment Shares previously issued to Lincoln Park) at an assumed average sale price of \$1.69 per share of our common stock, which was the closing sale price of our common stock on Nasdaq on August 8, 2023, without giving effect to the Exchange Cap under the Purchase Agreement, and after deducting estimated aggregate offering expenses payable by us, our as adjusted net tangible book value as of June 30, 2023 would have been approximately \$97.1 million, or \$0.50 per share of common stock. This represents an immediate increase in net tangible book value per share of \$0.19 to our existing stockholders and an immediate dilution in net tangible book value of \$1.19 per share to Lincoln Park. The following table illustrates this per share dilution:

Assumed offering price per share	\$	1.69
Net tangible book value per share as of June 30, 2023	\$	0.31
Increase in net tangible book value per share attributable to Lincoln Park	\$	0.19
As adjusted net tangible book value per share after giving effect to the offering	\$	0.50
Dilution per share to Lincoln Park	\$	1.19

The number of shares of our common stock outstanding is based on 164,418,011 shares of our common stock outstanding as of June 30, 2023 and excludes the following:

- 3,583,186 shares of our common stock issuable upon the exercise of options outstanding as of June 30, 2023, having a weighted average exercise price of \$4.47 per share;
- 5,859,232 shares of our common stock issuable upon the vesting and settlement of outstanding restricted stock unit awards, outstanding as of June 30, 2023, having a weighted average grant date fair value of \$1.40 per share;
- 32,414,134 shares of common stock issuable upon the exercise of pre-funded warrants, outstanding as of June 30, 2023, with 29,589,436 having an exercise price of \$0.001 per share and 2,824,698 having an exercise price of \$0.01 per share;
- 80,246,459 shares of our common stock issuable upon the exercise of warrants outstanding as of June 30, 2023, having a weighted average exercise price of \$1.88 per share;
- 9,067,537 shares of common stock reserved for future issuance under our Amended and Restated 2017 Equity Incentive Plan, Amended and Restated 2017 Employee Stock Purchase Plan and 2019 Inducement Equity Incentive Plan as of June 30, 2023; and
- Up to \$75.0 million of our shares of common stock that may be sold from time to time under an “at the market” equity offering program that we entered into on August 7, 2020 with B. Riley Securities, Inc., Cantor Fitzgerald & Co. and Stifel, Nicolaus & Company, Incorporated, of which approximately \$15.0 million have been sold to date.

The shares subject to the Purchase Agreement are being sold from time to time at various prices. An increase of \$1.00 per share in the price at which the shares are sold from the assumed offering price of \$1.69 per share shown in the table above, assuming all of our common stock in the aggregate amount of \$47.0 million during the term of the Purchase Agreement is sold at that price, would increase our pro forma as adjusted net tangible book value per share to \$0.53 per share and would decrease the dilution in net tangible book value per share to investors purchasing in this offering to \$1.16 per share, after deducting estimated offering expenses payable by us. A decrease of \$1.00 per share in the price at which the shares are sold from the assumed offering price of \$1.69 per share shown in the table above, assuming all of our common stock in the aggregate amount of \$75.0 million during the term of the Purchase Agreement is sold at that price, would decrease our pro forma as adjusted net tangible book value per share to \$0.42 per share and would increase the dilution in net tangible book value per share to investors purchasing in this offering to \$1.27 per share, after deducting estimated offering expenses payable by us. This information is supplied for illustrative purposes only.

To the extent that any of these outstanding options or warrants are exercised or restricted stock units vest, or sales are made pursuant to the Purchase Agreement, there will be further dilution to new investors. In addition, we may choose to raise additional capital due to market conditions or strategic considerations even if we believe we have sufficient funds for our current or future operating plans. To the extent that additional capital is raised through the sale of equity or convertible debt securities, the issuance of these securities may result in further dilution to our stockholders.

LINCOLN PARK TRANSACTION

General

On January 14, 2022, we entered into the Purchase Agreement with Lincoln Park. In connection with the Purchase Agreement, on January 14, 2022, we also entered into a registration rights agreement, or the Registration Rights Agreement, with Lincoln Park, pursuant to which we agreed to take specified actions to maintain the registration of the shares of our common stock subject to the offering described in this prospectus. Pursuant to the terms of the Purchase Agreement, Lincoln Park has agreed to purchase from us up to \$50,000,000 of our common stock (subject to certain limitations) from time to time during the term of the Purchase Agreement. Pursuant to the terms of the Purchase Agreement and Registration Rights Agreement, we are filing with the SEC this prospectus regarding the offer and sale under the Securities Act of the shares of common stock that we may issue and sell to Lincoln Park under the Purchase Agreement. Pursuant to the terms of the Purchase Agreement, on January 14, 2022, we sold to Lincoln Park (i) 1,382,488 Initial Purchase Shares at a per share price of \$2.17 for an aggregate purchase price of approximately \$3,000,000, as an initial purchase under the Purchase Agreement, and (ii) 230,414 Commitment Shares, as consideration for Lincoln Park's commitment to purchase shares of our common stock under the Purchase Agreement.

In addition to the Initial Purchase Shares and Commitment Shares, we may, from time to time and at our sole discretion, direct Lincoln Park to purchase up to an additional \$47,000,000 of shares of our common stock at a purchase price per share based on the market price of our common stock at the time of sale as calculated under the Purchase Agreement. Lincoln Park may not assign or transfer its rights and obligations under the Purchase Agreement.

Under applicable rules of the Nasdaq Capital Market, in no event may we issue or sell to Lincoln Park under the Purchase Agreement shares of our common stock in excess of 5,622,718 shares (including the Commitment Shares), which represents 19.99% of the shares of our common stock outstanding immediately prior to the execution of the Purchase Agreement, or the Exchange Cap, unless (i) we obtain stockholder approval to issue shares of our common stock in excess of the Exchange Cap or (ii) the average price of all applicable sales of our common stock to Lincoln Park under the Purchase Agreement equals or exceeds \$2.17 per share (which represents the lower of (A) the official closing price of our common stock on Nasdaq on the trading day immediately preceding the date of the Purchase Agreement and (B) the average official closing price of our common stock on Nasdaq for the five consecutive trading days ending on the trading day immediately preceding the date of the Purchase Agreement), adjusted such that the transactions contemplated by the Purchase Agreement are exempt from the Exchange Cap limitation under applicable Nasdaq rules. In any event, the Purchase Agreement specifically provides that we may not issue or sell any shares of our common stock under the Purchase Agreement if such issuance or sale would breach any applicable rules or regulations of the Nasdaq Capital Market.

The Purchase Agreement also prohibits us from directing Lincoln Park to purchase any shares of our common stock if those shares, when aggregated with all other shares of our common stock then beneficially owned by Lincoln Park, would result in Lincoln Park beneficially owning more than 9.99% of our outstanding shares of common stock.

Purchase of Shares under the Purchase Agreement

Regular Purchases

Under the Purchase Agreement, on any business day after January 14, 2022 selected by us over the 36-month term of the Purchase Agreement, or each such date a Purchase Date, we may direct Lincoln Park to purchase up to 50,000 shares of our common stock on such Purchase Date, or a Regular Purchase, if the closing sale price of our common stock on the Nasdaq Capital Market is not below \$1.00 on the applicable Purchase Date; provided, however, that (i) a Regular Purchase may be increased to up to 75,000 shares, if the closing sale price of our common stock on Nasdaq is not below \$7.50 on the applicable Purchase Date; and (ii) a Regular Purchase may be increased to up to 100,000 shares, if the closing sale price of our common stock on Nasdaq is not below \$10.00 on the applicable

Purchase Date; provided, that Lincoln Park's maximum purchase obligation under any single Regular Purchase will not exceed \$2,000,000. In any case, the maximum amount of any single Regular Purchase may be increased upon the mutual agreement of the parties. We may direct Lincoln Park to purchase shares in Regular Purchases as often as every business day, provided that all Purchase Shares subject to all prior Regular Purchases have been delivered to Lincoln Park in accordance with the Purchase Agreement. The foregoing share amounts and per share prices will be adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction occurring after the date of this prospectus, as set forth in the Purchase Agreement.

The purchase price per share for each such Regular Purchase will be equal to the lesser of:

- the lowest sale price for our common stock on the Nasdaq Capital Market on the date of sale; and
- the average of the three lowest closing sale prices for our common stock on the Nasdaq Capital Market during the 10 consecutive business days ending on the business day immediately preceding the purchase date.

Accelerated Purchases

We also have the right to direct Lincoln Park, on any business day on which we have properly submitted a Regular Purchase notice for the maximum amount we are then permitted to sell to Lincoln Park in such Regular Purchase, to purchase an additional amount of our common stock, or an Accelerated Purchase, of up to the lesser of:

- 300% of the number of shares to be purchased pursuant to such Regular Purchase; and
- 30% of the aggregate shares of our common stock traded on the Nasdaq Capital Market during all or, if certain trading volume or market price thresholds specified in the Purchase Agreement are crossed on the applicable Accelerated Purchase date, the portion of the normal trading hours on the applicable Accelerated Purchase date prior to such time that any one of such thresholds is crossed, which period of time on the applicable Accelerated Purchase date we refer to as the Accelerated Purchase Measurement Period.

The parties may mutually agree to increase the number of shares to be purchased by Lincoln Park pursuant to any Accelerated Purchase.

The purchase price per share for each such Accelerated Purchase will be equal to 97% of the lesser of:

- the volume-weighted average price of our common stock on the Nasdaq Capital Market during the applicable Accelerated Purchase Measurement Period on the applicable Accelerated Purchase date; and
- the closing sale price of our common stock on the Nasdaq Capital Market on the applicable Accelerated Purchase date.

Additional Accelerated Purchases

We also have the right to direct Lincoln Park on any business day on which an Accelerated Purchase has been completed and all of the shares to be purchased thereunder have been properly delivered to Lincoln Park in accordance with the Purchase Agreement to purchase an additional amount of our common stock, or an Additional Accelerated Purchase, of up to the lesser of:

- 300% of the number of shares purchased pursuant to the applicable corresponding Regular Purchase; and

- 30% of the aggregate shares of our common stock traded on the Nasdaq Capital Market during all or, if certain trading volume or market price thresholds specified in the Purchase Agreement are crossed on the applicable Additional Accelerated Purchase date, the portion of the normal trading hours on the applicable Additional Accelerated Purchase date prior to such time that any one of such thresholds is crossed, which period of time on the applicable Additional Accelerated Purchase date we refer to as the Additional Accelerated Purchase Measurement Period.

The parties may mutually agree to increase the number of shares to be purchased by Lincoln Park pursuant to any Additional Accelerated Purchase.

We may, in our sole discretion, submit multiple Additional Accelerated Purchase notices to Lincoln Park on a single Accelerated Purchase date, provided that all prior Accelerated Purchases and Additional Accelerated Purchases (including those that have occurred earlier on the same day) have been completed and all of the shares to be purchased thereunder have been properly delivered to Lincoln Park in accordance with the Purchase Agreement.

The purchase price per share for each such Additional Accelerated Purchase will be equal to 97% of the lower of:

- the volume-weighted average price of our common stock on the Nasdaq Capital Market during the applicable Additional Accelerated Purchase Measurement Period on the applicable Additional Accelerated Purchase date; and
- the closing sale price of our common stock on the Nasdaq Capital Market on the applicable Additional Accelerated Purchase date.

In the case of Regular Purchases, Accelerated Purchases and Additional Accelerated Purchases, the purchase price per share will be equitably adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction occurring during the business days used to compute the purchase price. Other than as described above, there are no trading volume requirements or restrictions under the Purchase Agreement, and we will control the timing and amount of any sales of our common stock to Lincoln Park.

Events of Default

Events of default under the Purchase Agreement include the following:

- the effectiveness of a registration statement registering the sale or resale of the Purchase Shares and Commitment Shares lapses for any reason (including, without limitation, the issuance of a stop order by the SEC), or any required prospectus supplement and accompanying prospectus are unavailable for the resale by Lincoln Park of our common stock offered hereby, and such lapse or unavailability continues for a period of 10 consecutive business days or for more than an aggregate of 30 business days in any 365-day period;
- suspension by the principal market of our common stock from trading or failure of the common stock to be listed on the Nasdaq Capital Market for a period of one business day;
- the de-listing of our common stock from the Nasdaq Capital Market, our principal market, unless our common stock is immediately thereafter trading on the Nasdaq Global Select Market, the Nasdaq Global Market, the New York Stock Exchange, the NYSE American, the NYSE Arca, the OTC Bulletin Board or the OTCQB or the OTCQX operated by the OTC Markets Group, Inc.(or any nationally recognized successor to any of the foregoing);
- the failure for any reason by our transfer agent to issue Purchase Shares to Lincoln Park within two business days after any Purchase Date, Accelerated Purchase date or Additional Accelerated Purchase date, as applicable, on which Lincoln Park is entitled to receive such Purchase Shares;

- any breach of the representations, warranties, covenants or other terms or conditions contained in the Purchase Agreement or Registration Rights Agreement that has or could have a Material Adverse Effect (as defined in the Purchase Agreement) and, in the case of a breach of a covenant that is reasonably curable, that is not cured within a period of at least five business days;
- our common stock ceases to be DTC authorized and ceases to participate in the DWAC/FAST systems or if we fail to maintain the service of our transfer agent (or a successor transfer agent) with respect to the issuance of Purchase Shares under the Purchase Agreement;
- if at any time the Exchange Cap (to the extent applicable under the terms of the Purchase Agreement) is reached and our stockholders have not approved the issuance of common stock in excess of the Exchange Cap in accordance with the applicable rules of the Nasdaq Capital Market; or
- any voluntary or involuntary participation or threatened participation in insolvency or bankruptcy proceedings by or against us.

Lincoln Park does not have the right to terminate the Purchase Agreement upon any of the events of default set forth above; however, the Purchase Agreement will automatically terminate upon initiation of insolvency or bankruptcy proceedings by or against us. During an event of default, all of which are outside of Lincoln Park's control, we are not permitted to direct Lincoln Park to purchase any shares of our common stock under the Purchase Agreement.

Our Termination Rights

We have the unconditional right, at any time, for any reason and without any payment or liability to us, to give one business day notice to Lincoln Park to terminate the Purchase Agreement.

No Short-Selling or Hedging by Lincoln Park

Lincoln Park has agreed that neither it nor any of its affiliates shall engage in any direct or indirect short-selling or hedging of our common stock during any time prior to the termination of the Purchase Agreement.

Prohibitions on Other Equity Lines of Credit

Subject to specified exceptions included in the Purchase Agreement, until the earlier of (i) the expiration of the 36-month term of the Purchase Agreement and (ii) the one-year anniversary of the termination of the Purchase Agreement by us prior to such expiration in accordance with the Purchase Agreement, we are limited in our ability to enter into any "equity line of credit" or other similar continuous offering in which we may offer, issue or sell common stock or securities convertible into or exercisable for common stock at a future determined price, other than an "at the market offering" exclusively through a registered broker-dealer acting as our agent.

Effect of Performance of the Purchase Agreement on our Stockholders

All shares registered in this offering that have been or may be issued or sold by us to Lincoln Park under the Purchase Agreement are expected to be freely tradable. Shares registered in this offering may be sold over a period commencing on the date of this prospectus and ending on February 1, 2025. The sale by Lincoln Park of a significant amount of shares registered in this offering at any given time could cause the market price of our common stock to decline and to be highly volatile. Sales of our common stock to Lincoln Park, if any, will depend upon market conditions and other factors to be determined by us, in our sole discretion. We may ultimately decide to sell to Lincoln Park all, some or none of the additional shares of our common stock that may be available for us to sell pursuant to the Purchase Agreement. If and when we do sell shares to Lincoln Park, after Lincoln Park has acquired the shares, Lincoln Park may resell all, some or none of those shares at any time or from time to time in its discretion. Therefore, sales to Lincoln Park by us under the Purchase Agreement may result in substantial dilution to the interests of other holders of our common stock. In addition, if we sell a substantial number of shares to Lincoln Park under the Purchase Agreement, or if investors expect that we will do so, the actual sales of shares or the mere existence of our arrangement with Lincoln Park may make it more difficult for us to sell equity or equity-related securities in the future at a time and at a price that we might otherwise wish to effect such sales. However, we have

the right to control the timing and amount of any additional sales of our shares to Lincoln Park and the Purchase Agreement may be terminated by us at any time at our discretion without any cost to us.

Pursuant to the terms of the Purchase Agreement, we have the right, but not the obligation, to direct Lincoln Park to purchase up to \$50,000,000 of our common stock (inclusive of the \$3,000,000 Initial Purchase Shares sold to Lincoln Park on January 14, 2022, but exclusive of the 230,414 Commitment Shares previously issued to Lincoln Park). The Purchase Agreement prohibits us from issuing or selling to Lincoln Park under the Purchase Agreement (i) shares of our common stock in excess of the Exchange Cap, unless we obtain stockholder approval to issue shares in excess of the Exchange Cap or the average price of all applicable sales of our common stock to Lincoln Park under the Purchase Agreement equals or exceeds \$2.17 per share, such that the transactions contemplated by the Purchase Agreement are exempt from the Exchange Cap limitation under applicable Nasdaq rules and (ii) any shares of our common stock if those shares, when aggregated with all other shares of our common stock then beneficially owned by Lincoln Park, would exceed than 9.99% of our outstanding shares of common stock.

Amount of Potential Proceeds to be Received under the Purchase Agreement

The following table sets forth the amount of gross proceeds we would receive from Lincoln Park from our sale of shares to Lincoln Park under the Purchase Agreement at varying purchase prices.

Assumed Average Purchase Price	Number of Registered Shares to be Issued if Full Purchase (1)	Percentage of Outstanding Shares After Giving Effect to the Issuance to Lincoln Park(2)	Gross Proceeds to Us from the Sale of Shares to Lincoln Park Under the Purchase Agreement
\$1.00	5,622,718	19.99%	\$5,622,718
\$1.69 (3)	5,622,718	19.99%	\$9,502,393
\$2.00	5,622,718	19.99%	\$11,245,436
\$2.50	5,622,718	19.99%	\$14,056,795
\$3.00	5,622,718	19.99%	\$16,868,154
\$5.00	5,622,718	19.99%	\$28,113,590
\$10.00	5,000,000	17.78%	\$50,000,000
\$15.00	3,333,333	11.85%	\$49,999,995

- (1) Includes the total number of Purchase Shares which we would have sold under the Purchase Agreement at the corresponding assumed average purchase price set forth in the first column, up to the aggregate purchase price of \$50,000,000, if available, while giving effect to the Exchange Cap and without regard for the limitation of 9.99% of our outstanding shares of common stock that Lincoln Park may beneficially own under the Purchase Agreement, and excludes the Commitment Shares.
- (2) The denominator is based on 28,127,657 shares outstanding as of January 13, 2022. The numerator is based on the number of shares issuable under the Purchase Agreement (that are the subject of this offering) at the corresponding assumed average purchase price set forth in the first column.
- (3) The closing sale price of our common stock on the Nasdaq Capital Market on August 8, 2023.

Information with Respect to Lincoln Park

Immediately prior to the date of the Purchase Agreement, Lincoln Park Capital Fund, LLC, beneficially owned 197,185 shares of Common Stock. Josh Scheinfeld and Jonathan Cope, the Managing Members of Lincoln Park Capital, LLC, the manager of Lincoln Park Capital Fund, LLC, are deemed to be beneficial owners of all of the Common Stock owned by Lincoln Park Capital Fund, LLC. Messrs. Cope and Scheinfeld have shared voting and investment power over the shares being offered under the prospectus supplement filed with the SEC in connection

with the transactions contemplated under the Purchase Agreement. Lincoln Park Capital, LLC is not a licensed broker dealer or an affiliate of a licensed broker dealer.

PLAN OF DISTRIBUTION

Pursuant to this prospectus, we are offering up to \$50,000,000 of shares of common stock that we may issue and sell to Lincoln Park from time to time pursuant to the Purchase Agreement and 230,414 shares of our common stock issued to Lincoln Park as Commitment Shares under the Purchase Agreement.

On January 14, 2022, the commencement date of the Purchase Agreement, we sold to Lincoln Park, as an initial purchase under the Purchase Agreement, 1,382,488 shares of common stock, at a per share price of \$2.17 per share, for aggregate consideration of approximately \$3,000,000, and we issued to Lincoln Park the 230,414 Commitment Shares. It is anticipated that shares offered to Lincoln Park in this offering will be sold from time to time until February 1, 2025. This prospectus and the accompanying prospectus also cover the resale of these shares by Lincoln Park to the public.

We may, from time to time after the date of this prospectus and at our sole discretion, direct Lincoln Park to purchase shares of our common stock in a Regular Purchase in amounts up to 50,000 shares on any single business day during the term of the Purchase Agreement on which the closing sale price of our common stock is at least

\$1.00, which amounts may be increased to up to 100,000 shares of our common stock depending on the market price of our common stock at the time of sale, subject to further increases upon the parties mutual agreement, which share amounts and related market prices will be adjusted for any reorganization, recapitalization, non-cash dividend, stock split, reverse stock split or other similar transaction occurring after the date of this prospectus, as set forth in the Purchase Agreement. In addition, upon notice to Lincoln Park, we may, from time to time and at our sole discretion, direct Lincoln Park to purchase additional shares of our common stock in Accelerated Purchases and Additional Accelerated Purchase as set forth in the Purchase Agreement. The purchase price per share in a Regular Purchase, Accelerated Purchase and Additional Accelerated Purchase will be based on the market price of our common stock at the time of sale as computed under the Purchase Agreement. Lincoln Park may not assign or transfer its rights and obligations under the Purchase Agreement. See “Lincoln Park Transaction-Purchases of Shares under the Purchase Agreement.”

Lincoln Park is an “underwriter” within the meaning of Section 2(a)(11) of the Securities Act.

We have agreed to indemnify Lincoln Park and certain other persons against certain liabilities in connection with the offering of shares of our common stock offered. We have agreed to reimburse Lincoln Park for certain of its expenses in connection with the offering.

Lincoln Park has represented to us that at no time prior to the Purchase Agreement has Lincoln Park or its agents, representatives or affiliates engaged in or effected, in any manner whatsoever, directly or indirectly, any short sale (as such term is defined in Rule 200 of Regulation SHO of the Exchange Act) of our common stock or any hedging transaction, which establishes a net short position with respect to our common stock. Lincoln Park agreed that during the term of the Purchase Agreement, it, its agents, representatives or affiliates will not enter into or effect, directly or indirectly, any of the foregoing transactions.

We have advised Lincoln Park that it is required to comply with Regulation M promulgated under the Exchange Act. With certain exceptions, Regulation M precludes Lincoln Park, any affiliated purchasers, and any broker-dealer or other person who participates in the distribution from bidding for or purchasing, or attempting to induce any person to bid for or purchase any security which is the subject of the distribution until the entire distribution is complete. Regulation M also prohibits any bids or purchases made in order to stabilize the price of a security in connection with the distribution of that security. All of the foregoing may affect the marketability of the securities offered by this prospectus.

This offering will terminate at the end of the “Registration Period” as defined in the Registration Rights Agreement following the date that all shares offered by this prospectus have been sold to Lincoln Park.

The transfer agent and registrar for our common stock is Computershare Trust Company, N.A. Our common stock is listed on the Nasdaq Capital Market under the symbol “XFOR.”

LEGAL MATTERS

The validity of the securities being offered hereby will be passed on by Cooley LLP, New York, New York.

EXPERTS

The financial statements incorporated in this prospectus by reference to the Annual Report on Form 10-K for the year ended December 31, 2022 have been so incorporated in reliance on the report (which contains an explanatory paragraph relating to the Company's ability to continue as a going concern as described in Note 1 to the financial statements) of PricewaterhouseCoopers LLP, an independent registered public accounting firm, given on the authority of said firm as experts in auditing and accounting.

WHERE YOU CAN FIND MORE INFORMATION

This prospectus is part of the registration statement on Form S-3 we filed with the SEC. This prospectus does not contain all of the information set forth in the registration statement and the exhibits to the registration statement. For further information with respect to us and the securities we are offering under this prospectus, we refer you to the registration statement and the exhibits and schedules filed as a part of the registration statement. You should rely only on the information contained in this prospectus or incorporated by reference herein or therein. We have not authorized anyone else to provide you with different information. We are not making an offer of these securities in any state where the offer is not permitted. You should not assume that the information in this prospectus is accurate as of any date other than the date on the front page of this prospectus, regardless of the time of delivery of this prospectus or any sale of the securities offered by this prospectus.

We file annual, quarterly and current reports, proxy statements and other information with the SEC. Our SEC filings are available to the public over the Internet at the SEC's website at <http://www.sec.gov>.

Copies of certain information filed by us with the SEC are also available on our website at www.x4pharma.com. Information contained in or accessible through our website does not constitute a part of this prospectus and is not incorporated by reference in this prospectus.

INCORPORATION OF CERTAIN INFORMATION BY REFERENCE

The SEC allows us to “incorporate by reference” information that we file with it, which means that we can disclose important information to you by referring you to those documents. The information incorporated by reference is an important part of this prospectus. Information in this prospectus supersedes information incorporated by reference that we filed with the SEC prior to the date of this prospectus, while information that we file later with the SEC will automatically update and supersede the information in this prospectus. We also incorporate by reference into this prospectus the documents listed below and any future filings made by us with the SEC (other than Current Reports or portions thereof furnished under Item 2.02 or Item 7.01 of Form 8-K and exhibits filed on such form that are related to such items and other portions of documents that are furnished, but not filed, pursuant to applicable rules promulgated by the SEC) that are filed by us with the SEC pursuant to Sections 13(a), 13(c), 14 or 15(d) of the Exchange Act prior to the termination of this offering, including all such reports and documents filed with the SEC after the date of the initial filing of the registration statement of which this prospectus forms a part but prior to the effectiveness of such registration statement:

- Our Annual Report on Form 10-K for the fiscal year ended December 31, 2022, filed with the SEC on [March 21, 2023](#), including the information specifically incorporated by reference in the Annual Report on Form 10-K from our definitive proxy statement for the 2023 Annual Meeting of Stockholders, filed with the SEC on [April 25, 2023](#) as supplemented on [April 27, 2023](#);
- Our Quarterly Report on Form 10-Q for the fiscal quarter ended March 31, 2023, filed with the SEC on [May 4, 2023](#) and our Quarterly Report on Form 10-Q for the fiscal quarter ended June 30, 2023, filed with the SEC on [August 10, 2023](#);
- Our Current Reports on Form 8-K filed with the SEC on [January 6, 2023](#), [March 10, 2023](#), [May 16, 2023](#), [June 15, 2023](#) and [August 3, 2023](#) (in each case, except for information contained therein which is furnished rather than filed); and
- The description of our common stock set forth in the registration statement on [Form 8-A](#) registering our common stock under Section 12 of the Exchange Act, which was filed with the SEC on November 15, 2017, including any amendments or reports filed for purposes of updating such description, including [Exhibit 4.17](#) to our Annual Report on Form 10-K for the fiscal year ended December 31, 2022.

We will provide to each person, including any beneficial owner, to whom a prospectus is delivered, without charge upon written or oral request, a copy of any or all of the documents that are incorporated by reference into this prospectus but not delivered with the prospectus, including exhibits that are specifically incorporated by reference into such documents. You should direct any requests for documents to X4 Pharmaceuticals, Inc., Attn: Investor Relations, 61 North Beacon Street, 4th Floor, Boston, Massachusetts 02134.

Any statement contained herein or in a document incorporated or deemed to be incorporated by reference into this document will be deemed to be modified or superseded for purposes of the document to the extent that a statement contained in this document or any other subsequently filed document that is deemed to be incorporated by reference into this document modifies or supersedes the statement.



**\$50,000,000 and
230,414 Shares of Common Stock**

PROSPECTUS

, 2023

PART II
INFORMATION NOT REQUIRED IN THE PROSPECTUS

Item 14. Other Expenses of Issuance and Distribution

The following table sets forth the estimated costs and expenses, other than underwriting discounts and commissions, payable by us in connection with the offering of the securities being registered. All the amounts shown are estimates, except for the SEC registration fee and FINRA filing fee.

SEC registration fee	\$14,244
FINRA filing fee	(1)
Accountants' fees and expenses	(1)
Legal fees and expenses	(1)
Transfer agent fees and expenses	(1)
Trustee fees and expenses	(1)
Printing and miscellaneous expenses	(1)
Total	<u>\$ 14,244</u>

⁽¹⁾ These fees are calculated based on the securities offered and the number of issuances and, accordingly, cannot be estimated at this time.

Item 15. Indemnification of Officers and Directors

Subsection (a) of Section 145 of the General Corporation Law of the State of Delaware, or the DGCL, empowers a corporation to indemnify any person who was or is a party or who is threatened to be made a party to any threatened, pending or completed action, suit or proceeding, whether civil, criminal, administrative or investigative (other than an action by or in the right of the corporation) by reason of the fact that the person is or was a director, officer, employee or agent of the corporation, or is or was serving at the request of the corporation as a director, officer, employee or agent of another corporation, partnership, joint venture, trust or other enterprise, against expenses (including attorneys' fees), judgments, fines and amounts paid in settlement actually and reasonably incurred by the person in connection with such action, suit or proceeding if the person acted in good faith and in a manner the person reasonably believed to be in or not opposed to the best interests of the corporation, and, with respect to any criminal action or proceeding, had no reasonable cause to believe the person's conduct was unlawful.

Subsection (b) of Section 145 empowers a corporation to indemnify any person who was or is a party or is threatened to be made a party to any threatened, pending or completed action or suit by or in the right of the corporation to procure a judgment in its favor by reason of the fact that the person acted in any of the capacities set forth above, against expenses (including attorneys' fees) actually and reasonably incurred by the person in connection with the defense or settlement of such action or suit if the person acted in good faith and in a manner the person reasonably believed to be in or not opposed to the best interests of the corporation, except that no indemnification shall be made in respect of any claim, issue or matter as to which such person shall have been adjudged to be liable to the corporation unless and only to the extent that the Court of Chancery or the court in which such action or suit was brought shall determine upon application that, despite the adjudication of liability but in view of all the circumstances of the case, such person is fairly and reasonably entitled to indemnity for such expenses which the Court of Chancery or such other court shall deem proper.

Section 145 further provides that to the extent a director or officer of a corporation has been successful on the merits or otherwise in the defense of any action, suit or proceeding referred to in subsections (a) and (b) of Section 145, or in defense of any claim, issue or matter therein, such person shall be indemnified against expenses (including attorneys' fees) actually and reasonably incurred by such person in connection therewith; that indemnification provided for by Section 145 shall not be deemed exclusive of any other rights to which the indemnified party may be entitled; and the indemnification provided for by Section 145 shall, unless otherwise provided when authorized or ratified, continue as to a person who has ceased to be a director, officer, employee or agent and shall inure to the benefit of such person's heirs, executors and administrators. Section 145 also empowers the corporation to purchase

and maintain insurance on behalf of any person who is or was a director, officer, employee or agent of the corporation, or is or was serving at the request of the corporation as a director, officer, employee or agent of another corporation, partnership, joint venture, trust or other enterprise against any liability asserted against such person and incurred by such person in any such capacity, or arising out of his status as such, whether or not the corporation would have the power to indemnify such person against such liabilities under Section 145.

Section 102(b)(7) of the DGCL provides that a corporation's certificate of incorporation may contain a provision eliminating or limiting the personal liability of a director to the corporation or its stockholders for monetary damages for breach of fiduciary duty as a director, provided that such provision shall not eliminate or limit the liability of a director (i) for any breach of the director's duty of loyalty to the corporation or its stockholders, (ii) for acts or omissions not in good faith or which involve intentional misconduct or a knowing violation of law, (iii) under Section 174 of the DGCL or (iv) for any transaction from which the director derived an improper personal benefit.

We have entered into indemnification agreements with each of our directors and executive officers, in addition to the indemnification provided for in our restated certificate, and intend to enter into indemnification agreements with any new directors in the future.

We have purchased and intend to maintain insurance on behalf of any person who is or was a director or officer of X4 Pharmaceuticals against any loss arising from any claim asserted against him or her and incurred by him or her in any such capacity, subject to certain exclusions. Certain of our non-employee directors may, through their relationships with their employers, be insured and/or indemnified against certain liabilities in their capacity as members of our board of directors.

The underwriting agreement, if any, entered into with respect to an offering of securities registered hereunder will provide for indemnification by any underwriters of any offering, our directors and officers who sign the registration statement and our controlling persons for some liabilities, including liabilities arising under the Securities Act.

On March 13, 2019, we completed our business combination with X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) in accordance with the terms of an Agreement and Plan of Merger, dated as of November 26, 2018, as amended on December 20, 2018 and March 8, 2019, or the Merger Agreement, that we entered into with X4 Therapeutics, Inc. and Artemis AC Corp., a Delaware corporation and our wholly owned subsidiary, or Merger Sub. Pursuant to the terms of the Merger Agreement, 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, which transaction we refer to as the Merger.

Under the Merger Agreement and subject to applicable law, from the effective time of the Merger (the "Effective Time") through the sixth anniversary of the date on which the Effective Time occurs, we and the corporation surviving the Merger between X4 Therapeutics, Inc. and Merger Sub (the "Surviving Corporation") shall each, jointly and severally, indemnify and hold harmless each person who was, as of the date of the Merger Agreement (November 26, 2018), or has been at any time prior to such date, or who became prior to the Effective Time, a director or officer of our company, X4 Therapeutics, Inc. or any of our or X4 Therapeutics, Inc.'s respective subsidiaries against all claims, losses, liabilities, damages, judgments, fines and reasonable fees, costs and expenses, including attorneys' fees and disbursements, incurred in connection with any claim, action, suit, proceeding or investigation, whether civil, criminal, administrative or investigative, arising out of or pertaining to the fact that such person is or was a director, officer, employee or agent of our company, X4 Therapeutics, Inc., or any of our or X4 Therapeutics, Inc.'s respective subsidiaries (or, while a director or officer of our company, X4 Therapeutics, Inc. or any of our or X4 Therapeutics, Inc.'s respective subsidiaries, is or was serving at the request of us, X4 Therapeutics, Inc. or any of our or X4 Therapeutics, Inc.'s respective subsidiaries as a director, officer, employee or agent of another person), whether asserted or claimed prior to, at or after the Effective Time, in each case, to the fullest extent permitted by applicable law. Subject to applicable law, each such director and officer will be entitled to advancement of expenses (including attorneys' fees) incurred in the defense of any such claim, action, suit, proceeding or investigation from each of us and the Surviving Corporation following receipt by us or the Surviving Corporation from such indemnified person of a request therefor; provided that any such person to whom expenses are advanced provides an undertaking, to the extent then required by the DGCL or the applicable governing

document of us or the Surviving Corporation, as applicable, to repay such advances if it is ultimately determined that such person is not entitled to indemnification.

Further, pursuant to the Merger Agreement, for a period of six years following the closing of the Merger (the “Closing”), the provisions of the Surviving Corporation’s certificate of incorporation and by-laws will contain provisions at least as favorable as the provisions relating to the indemnification, advancement of expenses and elimination of liability for monetary damages set forth in the certificate of incorporation and by-laws of X4 Therapeutics, Inc. and us immediately before the Effective Time.

Pursuant to the Merger Agreement, we agreed to either (A) maintain in effect for six years after the Closing, our existing directors’ and officers’ insurance policies in place as of the date of the Merger Agreement (November 26, 2018), or (B) prior to the Closing, purchase a six-year “tail” policy under its own existing directors’ and officers’ liability insurance policy, with an effective date as of the Closing (provided, that we may substitute therefor a policy of at least the same coverage containing terms and conditions that are not less favorable in any material respect). In no event, however, will we be required to expend for an annual premium for such policies more than an amount equal to 200% of the annual premiums paid by us for such insurance as of the date of the Merger Agreement. During the term of the “tail” policy, however, neither we nor the Surviving Corporation may take any action following the Closing to cause such “tail” policy to be cancelled or any of its provisions to be amended or waived in any manner that would adversely affect in any material respect the rights of their former and current officers and directors, their heirs or representatives.

From and after the Effective Time, we agreed to pay all expenses, including reasonable attorneys’ fees, that may be incurred by indemnified persons in connection with their successful enforcement of the rights provided to such persons in the Merger Agreement. All rights to exculpation, indemnification and advancement of expenses for acts or omissions occurring at or prior to the Effective Time, whether asserted or claimed prior to, at or after the Effective Time, existing in favor of the current or former directors, officers or employees, as the case may be, of our company, X4 Therapeutics, Inc. or any of our or X4 Therapeutics, Inc.’s respective subsidiaries as provided in their respective certificates of incorporation or by-laws or other organization documents or in any agreement in existence immediately before the Effective Time, will survive the Merger and continue in full force and effect. The director and officer indemnification provisions of the Merger Agreement are intended to be in addition to the rights otherwise available to the current and former officers and directors of our company and X4 Therapeutics, Inc. by law, charter, statute, bylaw or agreement, and shall operate for the benefit of, and will be enforceable by, each of such indemnified persons, their heirs and their representatives.

In the event we or the Surviving Corporation or any of our or its respective successors or assigns (i) consolidates with or merges into any other person and is not be the continuing or surviving corporation or entity of such consolidation or merger, or (ii) transfers all or substantially all of its properties and assets to any person, then, and in each such case, proper provision will be made so that the successors and assigns of us or the Surviving Corporation, as the case may be, will succeed to the indemnification obligations set forth in the Merger Agreement. We will cause the Surviving Corporation to perform all of the director and officer indemnification obligations of the Surviving Corporation under the Merger Agreement.

Insofar as the forgoing provisions permit indemnification of directors, executive officers, or persons controlling us for liability arising under the Securities Act of 1933, as amended, or the Securities Act, we have been informed that, in the opinion of the Securities and Exchange Commission, such indemnification is against public policy as expressed in the Securities Act and is therefore unenforceable.

Item 16. Exhibits and Financial Statement Schedules

Exhibit Number	Description of Document
1.1 *	Form of Underwriting Agreement.
1.2	Controlled Equity OfferingSM Sales Agreement, dated August 7, 2020, by and among the Registrant and B. Riley Securities, Inc., Cantor Fitzgerald & Co., and Stifel Nicolaus & Company, Incorporated (incorporated by reference to Exhibit 1.2 to the Registrant's Registration Statement on Form S-3 (File No. 333-242372), filed with the SEC on August 7, 2020).
1.3	Purchase Agreement, dated as of January 14, 2022, by and between X4 Pharmaceuticals, Inc. and Lincoln Park Capital Fund, LLC (incorporated by reference to Exhibit 10.1 to the Registrant's Current Report on Form 8-K (File No. 001-38295), filed with the SEC on January 14, 2022).
3.1	Restated Certificate of Incorporation, as amended, of the Registrant (incorporated by reference to Exhibit 3.1 to the Registrant's Current Report on Form 8-K (File No. 001-38295), filed with the SEC on September 1, 2022).
3.2	Amended and Restated By-laws of the Registrant (incorporated by reference to Exhibit 3.2 to the Registrant's Current Report on Form 8-K (File No. 001-38295), filed with the SEC on November 20, 2017).
4.1	Reference is made to Exhibits 3.1 and 3.2 .
4.2	Registration Rights Agreement, dated as of January 14, 2022, by and between X4 Pharmaceuticals, Inc. and Lincoln Park Capital Fund, LLC (incorporated by reference to Exhibit 10.2 to the Registrant's Current Report on Form 8-K (File No. 001-38295), filed with the SEC on January 14, 2022).
4.3	Form of Common Stock Certificate (incorporated by reference to Exhibit 4.1 to the Registrant's Current Report on Form 8-K (File No. 001-38295) filed with the SEC on March 13, 2019).
4.4	Form of Indenture, between the Registrant and one or more trustees to be named (incorporated by reference to Exhibit 4.3 to the Registrant's Registration Statement on Form S-3 (File No. 333-242372) filed with the SEC on August 7, 2020).
4.5 *	Form of Note.
4.6	Form of Common Stock Warrant Agreement and Warrant Certificate (incorporated by reference to Exhibit 4.5 to the Registrant's Registration Statement on Form S-3 (File No. 333-242372) filed with the SEC on August 7, 2020).
4.7	Form of Preferred Stock Warrant Agreement and Warrant Certificate (incorporated by reference to Exhibit 4.6 to the Registrant's Registration Statement on Form S-3 (File No. 333-242372) filed with the SEC on August 7, 2020).
4.8	Form of Debt Securities Warrant Agreement and Warrant Certificate (incorporated by reference to Exhibit 4.7 to the Registrant's Registration Statement on Form S-3 (File No. 333-242372) filed with the SEC on August 7, 2020).
4.9 *	Form of Specimen Preferred Stock Certificate and Certificate of Designations of Preferred Stock.

Exhibit Number	Description of Document, cont.
5.1	Opinion of Cooley LLP.
23.1	Consent of PricewaterhouseCoopers LLP
23.2	Consent of Cooley LLP (included in Exhibit 5.1).
24.1	Powers of Attorney (included on signature page).
25.1 **	Statement of Eligibility of Trustee under the Indenture.
107	Filing Fee Table

* To be filed, if applicable, by amendment or as an exhibit to a Current Report on Form 8-K and incorporated herein by reference.

** To be filed, if applicable, in accordance with the requirements of Section 305(b)(2) of the Trust Indenture Act of 1939, as amended.

Item 17. Undertakings

The undersigned registrant hereby undertakes:

(1) To file, during any period in which offers or sales are being made, a post-effective amendment to this registration statement:

- (i) To include any prospectus required by Section 10(a)(3) of the Securities Act;
- (ii) To reflect in the prospectus any facts or events arising after the effective date of the registration statement (or the most recent post-effective amendment thereof) which, individually or in the aggregate, represent a fundamental change in the information set forth in the registration statement. Notwithstanding the foregoing, any increase or decrease in volume of securities offered (if the total dollar value of securities offered would not exceed that which was registered) and any deviation from the low or high end of the estimated maximum offering range may be reflected in the form of prospectus filed with the SEC pursuant to Rule 424(b) if, in the aggregate, the changes in volume and price represent no more than 20 percent change in the maximum aggregate offering price set forth in the "Calculation of Filing Fee Tables" in the effective registration statement; and
- (iii) To include any material information with respect to the plan of distribution not previously disclosed in the registration statement or any material change to such information in the registration statement;

provided, however, that the undertakings set forth in paragraphs (1)(i), (1)(ii) and (1)(iii) above do not apply if the registration statement is on Form S-3 and the information required to be included in a post-effective amendment by those paragraphs is contained in reports filed with or furnished to the SEC by the registrant pursuant to Section 13 or Section 15(d) of the Securities Exchange Act of 1934, as amended, or the Exchange Act, that are incorporated by reference in this registration statement or are contained in a form of prospectus filed pursuant to Rule 424(b) that is part of this registration statement.

(2) That, for the purpose of determining any liability under the Securities Act, each such post-effective amendment shall be deemed to be a new registration statement relating to the securities offered therein, and the offering of such securities at that time shall be deemed to be the initial *bona fide* offering thereof.

(3) To remove from registration by means of a post-effective amendment any of the securities being registered which remain unsold at the termination of the offering.

(4) That, for the purpose of determining liability under the Securities Act to any purchaser:

(i) Each prospectus filed by the registrant pursuant to Rule 424(b)(3) shall be deemed to be part of the registration statement as of the date the filed prospectus was deemed part of and included in the registration statement; and

(ii) Each prospectus required to be filed pursuant to Rule 424(b)(2), (b)(5), or (b)(7) as part of a registration statement in reliance on Rule 430B relating to an offering made pursuant to Rule 415(a)(1)(i), (vii), or (x) for the purpose of providing the information required by Section 10(a) of the Securities Act shall be deemed to be part of and included in the registration statement as of the earlier of the date such form of prospectus is first used after effectiveness or the date of the first contract of sale of securities in the offering described in the prospectus. As provided in Rule 430B, for liability purposes of the issuer and any person that is at that date an underwriter, such date shall be deemed to be a new effective date of the registration statement relating to the securities in the registration statement to which that prospectus relates, and the offering of such securities at that time shall be deemed to be the initial *bona fide* offering thereof. *Provided, however,* that no statement made in a registration statement or prospectus that is part of the registration statement or made in a document incorporated or deemed incorporated by reference into the registration statement or prospectus that is part of the registration statement will, as to a purchaser with a time of contract of sale prior to such effective date, supersede or modify any statement that was made in the registration statement or prospectus that was part of the registration statement or made in any such document immediately prior to such effective date.

(5) That, for the purpose of determining liability of the registrant under the Securities Act to any purchaser in the initial distribution of the securities, the undersigned registrant undertakes that in a primary offering of securities of the undersigned registrant pursuant to this registration statement, regardless of the underwriting method used to sell the securities to the purchaser, if the securities are offered or sold to such purchaser by means of any of the following communications, the undersigned registrant will be a seller to the purchaser and will be considered to offer or sell such securities to such purchaser: (i) any preliminary prospectus or prospectus of the undersigned registrant relating to the offering required to be filed pursuant to Rule 424; (ii) any free writing prospectus relating to the offering prepared by or on behalf of the undersigned registrant or used or referred to by the undersigned registrant; (iii) the portion of any other free writing prospectus relating to the offering containing material information about the undersigned registrant or its securities provided by or on behalf of the undersigned registrant; and (iv) any other communication that is an offer in the offering made by the undersigned registrant to the purchaser.

(6) That, for purposes of determining any liability under the Securities Act, each filing of the registrant's annual report pursuant to Section 13(a) or 15(d) of the Exchange Act (and, where applicable, each filing of an employee benefit plan's annual report pursuant to Section 15(d) of the Exchange Act) that is incorporated by reference in the registration statement shall be deemed to be a new registration statement relating to the securities offered therein, and the offering of such securities at that time shall be deemed to be the initial *bona fide* offering thereof.

(7) To file an application for the purpose of determining the eligibility of the trustee to act under subsection (a) of Section 310 of the Trust Indenture Act in accordance with the rules and regulations prescribed by the SEC under Section 305(b)(2) of the Trust Indenture Act.

(8) Insofar as indemnification for liabilities arising under the Securities Act may be permitted to directors, officers and controlling persons of the registrant pursuant to the foregoing provisions, or otherwise, the registrant has been advised that in the opinion of the SEC such indemnification is against public policy as expressed in the Securities Act and is, therefore, unenforceable. In the event that a claim for indemnification against such liabilities (other than the payment by the registrant of expenses incurred or paid by a director, officer or controlling person of the registrant in the successful defense of any action, suit or proceeding) is asserted by such director, officer or controlling person in connection with the securities being registered, the registrant will, unless in the opinion of its counsel the matter has been settled by controlling precedent, submit to a court of appropriate jurisdiction the question whether such indemnification by it is against public policy as expressed in the Securities Act and will be governed by the final adjudication of such issue.

SIGNATURES

Pursuant to the requirements of the Securities Act of 1933, as amended, the Registrant certifies that it has reasonable grounds to believe that it meets all of the requirements for filing on Form S-3 and has duly caused this Registration Statement to be signed on its behalf by the undersigned, thereunto duly authorized, in the City of Boston, Commonwealth of Massachusetts, on this 11th day of August, 2023.

X4 PHARMACEUTICALS, INC.

By: /s/ Paula Ragan
Paula Ragan, Ph.D.

President and Chief Executive Officer

POWER OF ATTORNEY

KNOW ALL PERSONS BY THESE PRESENTS, that each person whose signature appears below hereby constitutes and appoints Paula Ragan, Ph.D. and Adam S. Mostafa, jointly and severally, as his or her true and lawful agent, proxy and attorneys-in-fact, with full power of substitution and resubstitution, for him or her and in his or her name, place and stead, in any and all capacities, to (i) act on, sign and file with the Securities and Exchange Commission any and all amendments (including post-effective amendments) to this registration statement together with all schedules and exhibits thereto and any subsequent registration statement filed pursuant to Rule 462(b) under the Securities Act of 1933, as amended, together with all schedules and exhibits thereto, (ii) act on, sign and file such certificates, instruments, agreements and other documents as may be necessary or appropriate in connection therewith, (iii) act on and file any supplement to any prospectus included in this registration statement or any such amendment or any subsequent registration statement filed pursuant to Rule 462(b) under the Securities Act of 1933, as amended, and (iv) take any and all actions which may be necessary or appropriate to be done, as fully for all intents and purposes as he or she might or could do in person, hereby approving, ratifying and confirming all that such agent, proxy and attorney-in-fact or any of his substitutes may lawfully do or cause to be done by virtue thereof.

Pursuant to the requirements of the Securities Act, this Registration Statement has been signed by the following persons in the capacities and on the dates indicated.

Signature	Title	Date
<u>/s/ Paula Ragan</u> Paula Ragan, Ph.D.	President, Chief Executive Officer and Director (<i>Principal Executive Officer</i>)	August 11, 2023
<u>/s/ Adam S. Mostafa</u> Adam S. Mostafa	Chief Financial Officer and Treasurer (<i>Principal Financial Officer and Principal Accounting Officer</i>)	August 11, 2023
<u>/s/ Michael S. Wyzga</u> Michael S. Wyzga	Chairman of the Board of Directors	August 11, 2023
<u>/s/ William E. Aliski</u> William E. Aliski	Director	August 11, 2023
<u>/s/ Gary J. Bridger</u> Gary J. Bridger, Ph.D	Director	August 11, 2023
<u>/s/ Françoise de Craecker</u> Françoise de Craecker	Director	August 11, 2023

Signature	Title	Date
<hr/> <i>/s/ Alison Lawton</i> Alison Lawton	Director	August 11, 2023
<hr/> <i>/s/ David McGirr</i> David McGirr, MBA	Director	August 11, 2023
<hr/> <i>/s/ Murray W. Stewart</i> Murray W. Stewart, M.D.	Interim Chief Medical Officer and Director	August 11, 2023

Calculation of Filing Fee Tables

Form S-3
(Form Type)

X4 Pharmaceuticals, Inc.
(Exact Name of Registrant as Specified in its Charter)

Table 1: Newly Registered and Carry Forward Securities

	Security Type	Security Class Title	Fee Calculation or Carry Forward Rule	Amount Registered	Proposed Maximum Offering Price Per Unit	Maximum Aggregate Offering Price	Fee Rate	Amount of Registration Fee	Carry Forward Form Type	Carry Forward File Number	Carry Forward Initial effective date	Filing Fee Previously Paid In Connection with Unsold Securities to be Carried Forward
Newly Registered Securities												
Fees to Be Paid	Equity											
	Equity											
	Debt											
	Other											
	Unallocated (Universal) Shelf	—	Rule 457(o)	(2)	(3)	\$129,247,246	0.0001102	\$14,244				
Fees Previously Paid	—	—	—	—	—	—	—	—				

Carryforward Securities												
Carry Forward Securities	Equity	Common Stock, par value \$0.001 per share (1)		(4)		\$85,471,434	0.0001298		S-3	333-242372	August 19, 2020	\$11,094
	Equity	Preferred Stock, par value \$0.001 per share (1)										
	Debt	Debt Securities (1)										
	Other	Warrants(1)										
	Unallocated (Universal) Shelf	Unallocated (Universal) Shelf	—	(4)		\$49,500,000	0.0001298		S-3	333-242372	August 19, 2020	\$6,425
	Unallocated (Universal) Shelf	Unallocated (Universal) Shelf	—	(5)		\$35,781,320	0.0001091		S-3	333-249544	October 26, 2020	\$3,903
	Total Offering Amounts					\$300,000,000		\$14,244				
	Total Fees Previously Paid											
	Total Fee Offsets											
	Net Fee Due							\$14,244				

- (1) Separate consideration may or may not be received for securities that are issuable upon the conversion or exercise of, or in exchange for, other securities offered hereby.
- (2) X4 Pharmaceuticals, Inc. (the “Registrant”) is registering hereunder such indeterminate number of shares of common stock and preferred stock, such indeterminate principal amount of debt securities and such indeterminate number of warrants to purchase common stock, preferred stock and/or debt securities to be sold by the Registrant from time to time at unspecified prices which shall have an aggregate initial offering price not to exceed \$300,000,000. If any debt securities are issued at an original issue discount, then the principal amount of such debt securities shall be in such greater amount as shall result in an aggregate initial offering price not to exceed \$300,000,000, less the aggregate dollar amount of all securities previously issued hereunder. The securities registered for sale also include such indeterminate number of shares of common stock and preferred stock as may be issued upon conversion of debt securities, such indeterminate number of shares of common stock that may be issued upon conversion of preferred stock and such indeterminate number of shares of common stock and preferred stock and principal amount of debt securities that may be issued upon exercise of warrants. In addition, pursuant to Rule 416 under the Securities Act of 1933, as amended (the “Securities Act”), the shares being registered hereunder include such indeterminate number of shares of common stock and preferred stock as may be issuable with respect to the shares being registered hereunder as a result of stock splits, stock dividends or similar transactions.

- (3) The proposed maximum offering price per share will be determined, from time to time, by the Registrant in connection with the issuance by the Registrant of the securities registered hereunder and is not specified as to each class of security pursuant to Instruction 2.A.iii.b. to the Calculation of Filing Fee Tables and Related Disclosure on Item 16(b) of Form S-3 under the Securities Act.
- (4) Pursuant to Rule 415(a)(6) under the Securities Act, the securities registered pursuant to this registration statement include \$134,971,434 of unsold securities (the “August 2020 Unsold Securities”) previously registered pursuant to the Registration Statement on Form S-3 (File No. 333-242372), which was declared effective on August 19, 2020 (the “August 2020 Registration Statement”). The August 2020 Unsold Securities include (x) \$34,971,434 of unsold common stock pursuant to the sales agreement prospectus included in the August 2020 Registration Statement and (y)(i) \$47,000,000 of unsold common stock and (ii) an aggregate of \$3,500,000 of shares of common stock previously issued to Lincoln Park Capital Fund, LLC pursuant to the prospectus supplement dated January 14, 2022. In connection with the filing of the August 2020 Registration Statement, the registrant paid a filing fee of \$17,519 associated with the offering of the August 2020 Unsold Securities (based on the filing fee rate in effect at the time of the filing of the August 2020 Registration Statement). The filing fee associated with the offering of the August 2020 Unsold Securities is hereby carried forward to be applied to the August 2020 Unsold Securities registered hereunder, and no additional filing fee is due with respect to the August 2020 Unsold Securities in connection with the filing of this registration statement. To the extent that, after the filing date hereof and prior to the effectiveness of this registration statement, the registrant sells any August 2020 Unsold Securities pursuant to the August 2020 Registration Statement, the registrant will identify in a pre-effective amendment to this registration statement the updated number of August 2020 Unsold Securities from the August 2020 Registration Statement to be included in this registration statement pursuant to Rule 415(a)(6) and the updated amount of new securities to be registered on this registration statement. Pursuant to Rule 415(a)(6), the offering of securities under the August 2020 Registration Statement will be deemed terminated as of the date of effectiveness of this registration statement.
- (5) Pursuant to Rule 415(a)(6) under the Securities Act, the securities registered pursuant to this registration statement include \$35,781,320 of unsold securities (the “October 2020 Unsold Securities”) previously registered pursuant to the Registration Statement on Form S-3 (File No. 333-249544), which was declared effective on October 26, 2020 (the “October 2020 Registration Statement”). In connection with the filing of the October 2020 Registration Statement, the registrant paid a filing fee of \$3,903 associated with the offering of the October 2020 Unsold Securities (based on the filing fee rate in effect at the time of the filing of the October 2020 Registration Statement). The filing fee associated with the offering of the October 2020 Unsold Securities is hereby carried forward to be applied to the October 2020 Unsold Securities registered hereunder, and no additional filing fee is due with respect to the October 2020 Unsold Securities in connection with the filing of this registration statement. To the extent that, after the filing date hereof and prior to the effectiveness of this registration statement, the registrant sells any October 2020 Unsold Securities pursuant to the October 2020 Registration Statement, the registrant will identify in a pre-effective amendment to this registration statement the updated number of October 2020 Unsold Securities from the October 2020 Registration Statement to be included in this registration statement pursuant to Rule 415(a)(6) and the updated amount of new securities to be registered on this registration statement. Pursuant to Rule 415(a)(6), the offering of securities under the October 2020 Registration Statement will be deemed terminated as of the date of effectiveness of this registration statement, other than with respect to the Class C warrants registered thereunder.
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Daniel I. Goldberg
+1 212 479 6722
dgoldberg@cooley.com

August 11, 2023

X4 Pharmaceuticals, Inc.
61 North Beacon Street, 4th Floor
Boston, MA 02134

Ladies and Gentlemen:

We have acted as counsel to X4 Pharmaceuticals, Inc., a Delaware corporation (the "**Company**"), in connection with the filing of a Registration Statement on Form S-3 (the "**Registration Statement**") by the Company under the Securities Act of 1933, as amended (the "**Securities Act**"), with the Securities and Exchange Commission (the "**Commission**"). The Registration Statement includes three prospectuses: (i) a base prospectus (the "**Base Prospectus**"), covering the offering by the Company of up to \$300,000,000 of its common stock, preferred stock, debt securities and/or warrants to purchase any of such securities, that provides it will be supplemented in the future by one or more prospectus supplements (each, a "**Prospectus Supplement**"), (ii) a sales agreement prospectus (the "**Sales Agreement Prospectus**"), covering up to \$75,000,000 (which amount is included in the \$300,000,000 amount set forth in the base prospectus) of shares (the "**Sales Agreement Shares**") of its common stock, par value \$0.001 per share, of the Company ("**Common Stock**") that may be sold under that certain Controlled Equity OfferingSM Sales Agreement, dated August 7, 2020, by and among the Company, B. Riley Securities, Inc., Cantor Fitzgerald & Co., and Stifel, Nicolaus & Company, Incorporated (the "**Sales Agreement**"), and (iii) a purchase agreement prospectus, covering up to \$50,000,000 (which amount is included in the \$300,000,000 amount set forth in the base prospectus) of shares (the "**Purchase Agreement Shares**") of its common stock that may be sold under that certain Purchase Agreement, dated as of January 14, 2022, by and between the Company and Lincoln Park Capital Fund, LLC (the "**Purchase Agreement**"). The Registration Statement, including the Base Prospectus (as supplemented from time to time by one or more Prospectus Supplements), the Sales Agreement Prospectus and the Purchase Agreement Prospectus will provide for the registration by the Company of:

- shares of Common Stock (the "**Base Prospectus Shares**");
- shares of preferred stock, par value \$0.001 per share, of the Company (the "**Preferred Stock**");
- debt securities, in one or more series (the "**Debt Securities**"), which may be issued pursuant to an indenture to be dated on or about the date of the first issuance of Debt Securities thereunder, by and between a trustee to be selected by the Company (the "**Trustee**") and the Company, in the form filed as Exhibit 4.3 to the Registration Statement and one or more indentures supplemental thereto with respect to any particular series of Debt Securities (the "**Indenture**");
- warrants to purchase Common Stock, Preferred Stock or Debt Securities (the "**Warrants**"), which may be issued under one or more warrant agreements, to be dated on or about the date of the first issuance of the Warrants thereunder, by and between a warrant agent to be selected by the Company (the "**Warrant Agent**") and the Company, in the forms filed as Exhibits 4.5, 4.6 and 4.7 to the Registration Statement, respectively (each, a "**Warrant Agreement**");
- the Sales Agreement Shares; and
- the Purchase Agreement Shares.

The Base Prospectus Shares, the Preferred Stock, the Debt Securities, the Warrants, the Sales Agreement Shares and the Purchase Agreement Shares, plus any additional Common Stock, Preferred Stock, Debt Securities and Warrants that may be registered pursuant to any registration statement that the Company may hereafter file with the Commission pursuant to Rule 462(b) under the Securities Act in

connection with an offering by the Company pursuant to the Registration Statement, are collectively referred to herein as the "**Securities**." The Securities are being registered for offer and sale from time to time pursuant to Rule 415 under the Securities Act.

In connection with this opinion, we have examined and relied upon such records, documents, certificates, opinions, memoranda and other instruments as in our judgment are necessary or appropriate to enable us to render the opinion expressed below. As to certain factual matters, we have relied upon a certificate of an officer of the Company and have not independently verified such matters.

In rendering this opinion, we have assumed the genuineness of all signatures; the authenticity of all documents submitted to us as originals; the conformity to originals of all documents submitted to us as copies; the accuracy, completeness and authenticity of certificates of public officials; and the due authorization, execution and delivery of all documents where authorization, execution and delivery are prerequisites to the effectiveness thereof.

With respect to our opinion as to the Base Prospectus Shares, we have assumed that, at the time of issuance and sale, a sufficient number of shares of Common Stock will be authorized and available for issuance and that the consideration for the issuance and sale of the Base Prospectus Shares (or Preferred Stock or Debt Securities convertible into, or Warrants exercisable for, Common Stock) will be in an amount that is not less than the par value of the Common Stock. With respect to our opinion as to the Preferred Stock, we have assumed that, at the time of issuance and sale, a sufficient number of shares of Preferred Stock will be authorized, designated and available for issuance and that the consideration for the issuance and sale of the Preferred Stock (or Debt Securities convertible into, or Warrants exercisable for, Preferred Stock) will be in an amount that is not less than the par value of the Preferred Stock. We have also assumed that any Debt Securities or Warrants offered under the Registration Statement, and the related Indenture and Warrant Agreement, will be executed in the forms filed as exhibits to the Registration Statement or incorporated by reference therein. We have also assumed that (i) with respect to Securities issuable upon conversion of any convertible Preferred Stock, such convertible Preferred Stock is duly authorized, validly issued, fully paid and nonassessable; and (ii) with respect to any Securities issuable upon conversion of any convertible Debt Securities or upon exercise of any Warrants, such convertible Debt Securities or Warrants will constitute valid and legally binding obligations of the Company, enforceable against the Company in accordance with their terms, except as enforcement may be limited by applicable bankruptcy, insolvency, reorganization, arrangement, moratorium or other similar laws affecting creditors' rights, and subject to general equity principles and to limitations on availability of equitable relief, including specific performance.

With respect to the Sales Agreement Shares, we have assumed (i) that each sale of the Sales Agreement Shares will be duly authorized by the Board of Directors of the Company, a duly authorized committee thereof or a person or body pursuant to an authorization granted in accordance with Section 152 of the General Corporation Law of the State of Delaware (the "**DGCL**"), (ii) that no more than 91,463,414 Sales Agreement Shares will be sold under the Sales Agreement pursuant to the Sales Agreement Prospectus and (iii) that the price at which the Sales Agreement Shares are sold will equal or exceed the par value of the Common Stock. We express no opinion to the extent that future issuances of securities of the Company, anti-dilution adjustments to outstanding securities of the Company and/or other matters cause the number of shares of Common Stock issuable under the Sales Agreement to exceed the number of shares of Common Stock available for issuance by the Company.

With respect to the Purchase Agreement Shares, we have assumed (i) that each sale of the Purchase Agreement Shares will be duly authorized by the Board of Directors of the Company, a duly authorized committee thereof or a person or body pursuant to an authorization granted in accordance with Section 152 of the DGCL and (ii) that no more than 60,975,609 Purchase Agreement Shares will be sold and (iii) that the price at which the Purchase Agreement Shares are sold will equal or exceed the par value of the Common Stock. We express no opinion to the extent that future issuances of securities of the Company, anti-dilution adjustments to outstanding securities of the Company and/or other matters cause the number of shares of Common Stock issuable under the Purchase Agreement to exceed the number of shares of Common Stock available for issuance by the Company.

Our opinion herein is expressed solely with respect to the DGCL and, as to the Debt Securities and the Warrants constituting valid and legally binding obligations of the Company, the laws of the State of New York. Our opinion is based on these laws as in effect on the date hereof. We express no opinion to the extent that any other laws are applicable to the subject matter hereof and express no opinion and provide no assurance as to compliance with any federal or state securities law, rule or regulation.

On the basis of the foregoing and in reliance thereon, and subject to the qualifications herein stated, we are of the opinion that:

1. With respect to the Base Prospectus Shares offered under the Registration Statement, provided that (a) the Registration Statement and any required post-effective amendment thereto have become effective under the Securities Act and the Base Prospectus and any and all Prospectus Supplement(s) required by applicable laws have been delivered and filed as required by such laws; (b) the issuance of the Base Prospectus Shares has been duly authorized by all necessary corporate action on the part of the Company; (c) the issuance and sale of the Base Prospectus Shares do not violate any applicable law, are in conformity with the Company's then operative certificate of incorporation (the "**Certificate of Incorporation**") and bylaws (the "**Bylaws**"), do not result in a default under or breach of any agreement or instrument binding upon the Company and comply with any applicable requirement or restriction imposed by any court or governmental body having jurisdiction over the Company; and (d) the certificates, if any, for the Base Prospectus Shares have been duly executed by the Company, countersigned by the transfer agent therefor and duly delivered to the purchasers thereof against payment therefor, then the Base Prospectus Shares, when issued and sold as contemplated in the Registration Statement, the Base Prospectus and the related Prospectus Supplement(s) and in accordance with a duly authorized, executed and delivered purchase, underwriting or similar agreement, or upon conversion of any convertible Preferred Stock, or convertible Debt Securities in accordance with their terms, or upon exercise of any Warrants in accordance with their terms, will be validly issued, fully paid and nonassessable.
2. With respect to the Preferred Stock offered under the Registration Statement, provided that (a) the Registration Statement and any required post-effective amendment thereto have become effective under the Securities Act and the Base Prospectus and any and all Prospectus Supplement(s) required by applicable laws have been delivered and filed as required by such laws; (b) the terms and issuance of the Preferred Stock have been duly authorized by all necessary corporate action on the part of the Company; (c) the terms of the shares of the Preferred Stock and their issuance and sale do not violate any applicable law, are in conformity with the Certificate of Incorporation and the Bylaws, do not result in a default under or breach of any agreement or instrument binding upon the Company and comply with any applicable requirement or restriction imposed by any court or governmental body having jurisdiction over the Company; and (d) the certificates, if any, for the Preferred Stock have been duly executed by the Company, countersigned by the transfer agent therefor and duly delivered to the purchasers thereof against payment therefor, then the Preferred Stock, when issued and sold as contemplated in the Registration Statement, the Base Prospectus and the related Prospectus Supplement(s) and in accordance with a duly authorized, executed and delivered purchase, underwriting or similar agreement, or upon conversion of any convertible Debt Securities in accordance with their terms, or upon exercise of any Warrants in accordance with their terms, will be validly issued, fully paid and nonassessable.
3. With respect to any series of the Debt Securities issued under the Indenture, and offered under the Registration Statement, provided that (a) the Registration Statement and any required post-effective amendment thereto have become effective under the Securities Act and the Base Prospectus and any and all Prospectus Supplement(s) required by applicable laws have been delivered and filed as required by such laws; (b) the Indenture has been duly authorized by the Company and the Trustee by all necessary corporate action; (c) the Indenture has been duly executed and delivered by the Company and the Trustee and has been qualified under the Trust Indenture Act of 1939, as amended; (d) the issuance and terms of the Debt Securities have been duly authorized by the Company by all necessary corporate action; (e) the terms of the Debt Securities and of their issuance and sale have been duly established in conformity with the Indenture so as not to violate any applicable law or result in a default under or breach of any agreement or instrument binding upon the Company, so as to be in conformity with the Certificate

of Incorporation and the Bylaws, and so as to comply with any requirement or restriction imposed by any court or governmental body having jurisdiction over the Company; and (f) the notes representing the Debt Securities have been duly executed and delivered by the Company and authenticated by the Trustee pursuant to the Indenture and delivered against payment therefor, then the Debt Securities, when issued and sold in accordance with the Indenture and a duly authorized, executed and delivered purchase, underwriting or similar agreement, or upon exercise of any Warrants in accordance with their terms, will be valid and legally binding obligations of the Company, except as may be limited by bankruptcy, insolvency, reorganization, moratorium or other similar laws relating to or affecting creditors' rights generally, and by general equitable principles (regardless of whether considered in a proceeding at law or in equity).

4. With respect to the Warrants issued under the Warrant Agreements and offered under the Registration Statement, provided that (a) the Registration Statement and any required post-effective amendment thereto have become effective under the Securities Act and the Base Prospectus and any and all Prospectus Supplement(s) required by applicable laws have been delivered and filed as required by such laws; (b) the applicable Warrant Agreement has been duly authorized by the Company and the Warrant Agent by all necessary corporate action; (c) the applicable Warrant Agreement has been duly executed and delivered by the Company and the Warrant Agent; (d) the issuance and terms of the Warrants have been duly authorized by the Company by all necessary corporate action; (e) the terms of the Warrants and of their issuance and sale have been duly established in conformity with the applicable Warrant Agreement and as described in the Registration Statement, the Base Prospectus and the related Prospectus Supplement(s), so as not to violate any applicable law or result in a default under or breach of any agreement or instrument binding upon the Company, so as to be in conformity with the Certificate of Incorporation and the Bylaws, and so as to comply with any requirement or restriction imposed by any court or governmental body having jurisdiction over the Company; and (f) the Warrants have been duly executed and delivered by the Company and authenticated by the Warrant Agent pursuant to the applicable Warrant Agreement and delivered against payment therefor, then the Warrants, when issued and sold as contemplated in the Registration Statement, the Base Prospectus and the Prospectus Supplement(s) and in accordance with the applicable Warrant Agreement and a duly authorized, executed and delivered purchase, underwriting or similar agreement, will be valid and legally binding obligations of the Company, except as may be limited by bankruptcy, insolvency, reorganization, moratorium or other similar laws relating to or affecting creditors' rights generally, and by general equitable principles (regardless of whether considered in a proceeding at law or in equity).

5. The Sales Agreement Shares, when sold and issued against payment therefor in accordance with the Sales Agreement, the Registration Statement and the Sales Agreement Prospectus, will be validly issued, fully paid and nonassessable.

6. The Purchase Agreement Shares, when sold and issued against payment therefor in accordance with the Purchase Agreement, the Registration Statement and the Purchase Agreement Prospectus, will be validly issued, fully paid and nonassessable.

* * * * *

We hereby consent to the filing of this opinion as an exhibit to the Registration Statement and to the reference to our firm under the caption "Legal Matters" in the Base Prospectus, the Sales Agreement Prospectus and the Purchase Agreement Prospectus. We further consent to the incorporation by reference of this opinion into any registration statement filed pursuant to Rule 462(b) under the Securities Act with respect to additional Securities. In giving such consents, we do not thereby admit that we are in the category of persons whose consent is required under Section 7 of the Securities Act or the rules and regulations of the Commission thereunder.

Our opinion set forth above is limited to the matters expressly set forth in this letter, and no opinion is implied or may be inferred beyond the matters expressly stated. This opinion speaks only as to law and facts in effect or existing as of the date hereof, and we undertake no obligation or responsibility to update



X4 Pharmaceuticals, Inc.
August 11, 2023
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or supplement this opinion to reflect any facts or circumstances that may hereafter come to our attention or any changes in law that may hereafter occur.

Very truly yours,

Cooley LLP

By: /s/ Daniel I. Goldberg
Daniel I. Goldberg

Cooley LLP 55 Hudson Yards New York, NY 10001-2157
t: (212) 479-6000 f: (212) 479-6275 cooley.com

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statement on Form S-3 of X4 Pharmaceuticals, Inc. of our report dated March 21, 2023 relating to the financial statements, which appears in X4 Pharmaceuticals, Inc.'s Annual Report on Form 10-K for the year ended December 31, 2022. We also consent to the reference to us under the heading "Experts" in such Registration Statement.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
August 11, 2023