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UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

FORM 10-Q

(Mark One)

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

For the quarterly period ended March 31, 2019

or

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

For the transition period from _____ to _____

Commission File Number: 001-38295

X4 PHARMACEUTICALS, INC.
(Exact name of registrant as specified in its charter)

Delaware	**27-3181608**
(State or other jurisdiction of incorporation or organization)	**(I.R.S. Employer Identification No.)**
955 Massachusetts Avenue, 4th Floor Cambridge, Massachusetts	**02139**
(Address of principal executive offices)	**(Zip Code)**

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

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

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock	**XFOR**	**The Nasdaq Capital Market**

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

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes ☒ No ☐

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

Large accelerated filer	☐	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 13(a) of the Exchange Act. ☒

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

As of May 5, 2019, the registrant had 12,420,778 shares of common stock outstanding.

X4 Pharmaceuticals, Inc.

EXPLANATORY NOTE

On March 13, 2019, X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc), or the Company, completed its business combination in accordance with the terms of the 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, by and among the Company, X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Artemis AC Corp., a Delaware corporation and a wholly owned subsidiary of the Company, or the Merger Sub, pursuant to which, among other matters, Merger Sub merged with and into X4 Therapeutics, Inc., with X4 Therapeutics, Inc. continuing as a wholly owned subsidiary of the Company and the surviving corporation of the merger, or the Merger. Following the Merger, on March 13, 2019, the Company effected a 1-for-6 reverse stock split of its common stock, or the Reverse Stock Split, and changed its name to "X4 Pharmaceuticals, Inc." Following the completion of the Merger, the business conducted by the Company became primarily the business conducted by X4 Therapeutics, Inc., which is a clinical-stage biopharmaceutical company focused on the discovery, development and commercialization of novel therapeutics for the treatment of rare diseases.

Unless otherwise noted, all references to common stock share and per share amounts in this Quarterly Report on Form 10-Q have been retroactively adjusted to reflect the conversion of shares in the Merger based on an Exchange Ratio of 0.5702 and, the Reverse Stock Split. As used herein, the words "the Company," "we," "us," and "our" refer to, for periods following the Merger, X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc.), together with is direct and indirect subsidiaries, and for periods prior to the Merger, X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.), and its direct and indirect subsidiaries, as applicable. In addition, the word "Arsanis" refers to the Company prior to the completion of the Merger, and we sometimes refer to X4 Therapeutics, Inc. as "X4."

CAUTIONARY NOTE REGARDING FORWARD-LOOKING STATEMENTS

This quarterly report includes forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, which we refer to as the Securities Act, and Section 21E of the Securities Exchange Act of 1934, as amended, which we refer to as the Exchange Act, that relate to future events or to our future operations or financial performance. Any forward-looking statement involves known and unknown risks, uncertainties and other factors that may cause our actual results, levels of activity, performance or achievements to differ materially from any future results, levels of activity, performance or achievements expressed or implied by such forward-looking statement. Forward-looking statements include statements, other than statements of historical fact, about, among other things:

- the progress, scope, cost, duration or results of our development activities, nonclinical studies and clinical trials of mavorixafor (X4P-001), X4P-002 and X4P-003 or any of our other product candidates or programs, such as the target indication(s) for development, the size, design, population, conduct, cost, objective or endpoints of any clinical trial, or the timing for initiation or completion of or availability of results from any clinical trial (including our planned trials for mavorixafor in WHIM syndrome, severe congenital neutropenia, or SCN, and Waldenström macroglobulinemia, or WM), for submission or approval of any regulatory filing or for meeting with regulatory authorities;
- the potential benefits 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, any product candidates that we may develop, and any related restrictions, limitations, or warnings in the label of any approved product candidates;
- our future operations, financial position, revenues, costs, expenses, uses of cash, capital requirements or our need for additional financing; and
- our strategies, prospects, plans, expectations or objectives.

Words such as, but not limited to, "believe," "expect," "anticipate," "estimate," "forecast," "intend," "may," "plan," "potential," "predict," "project," "targets," "likely," "will," "would," "could," "should," "continue," "scheduled" and similar expressions or phrases, or the negative of those expressions or phrases, are intended to identify forward-looking statements, although not all forward-looking statements contain these identifying words. Although we believe that we have a reasonable basis for each forward-looking statement contained in this report, we caution you that these statements are based on our estimates or projections of the future that are subject to known and unknown risks and uncertainties and other important factors that may cause our actual results, level of activity, performance, experience or achievements to differ materially from those expressed or implied by any forward-looking statement. These risks, uncertainties and other factors are described in greater detail under the caption "Risk Factors" contained in our Annual Report on Form 10-K for the fiscal year ended December 31, 2018, as updated by our Current Report on Form 8-K filed on April 11, 2019 and our subsequent filings under the Exchange Act, and in other filings that we make with the Securities and Exchange Commission, or SEC. As a result of the risks and uncertainties, the results or events indicated by the forward-looking statements may not occur. We caution you not to place undue reliance on any forward-looking statement.

In addition, any forward-looking statement in this quarterly report represents our views only as of the date of this quarterly report and should not be relied upon as representing our views as of any subsequent date. We anticipate that subsequent events and developments may cause our views to change. Although we may elect to update these forward-looking statements publicly at some point in the future, we specifically disclaim any obligation to do so, except as required by applicable law. Our forward-looking statements do not reflect the potential impact of any future acquisitions, mergers, dispositions, joint ventures or investments we may make.

PART I: FINANCIAL INFORMATION

Item 1. FINANCIAL STATEMENTS

X4 PHARMACEUTICALS, INC.

CONDENSED CONSOLIDATED BALANCE SHEETS

(In thousands, except share and per share amounts)

(Unaudited)

	March 31, 2019	December 31, 2018
Assets		
Current assets:		
Cash and cash equivalents	$ 22,299	$ 8,134
Research and development incentive receivable	1,552	—
Prepaid expenses and other current assets	2,372	1,205
Total current assets	26,223	9,339
Property and equipment, net	271	241
Intangible assets	4,900	—
Goodwill	27,407	—
Right-of-use assets	2,705	—
Restricted cash	947	364
Other assets	96	—
Total assets	$ 62,549	$ 9,944
Liabilities, Convertible Preferred Stock, Redeemable Common Stock and Stockholders' Equity (Deficit)		
Current liabilities:		
Accounts payable	$ 6,132	$ 2,969
Accrued expenses	4,179	3,251
Current portion of lease liability	841	—
Current portion of long-term debt	5,298	1,687
Total current liabilities	16,450	7,907
Preferred stock warrant liability	—	4,947
Long-term debt, including accretion, net of discount and current portion	13,365	8,145
Deferred rent	—	417
Lease liability	3,275	—
Other liabilities	18	205
Total liabilities	33,108	21,621
Commitments and contingencies (Note 9)		
Convertible preferred stock (Series Seed, A and B), $0.001 par value; 10,000,000 and 59,413,523 shares authorized as of March 31, 2019 and December 31, 2018, respectively; 0 and 40,079,567 shares issued and outstanding as of March 31, 2019 and December 31, 2018, respectively	—	64,675
Redeemable common stock, $0.001 par value; 0 and 107,364 shares issued and outstanding as of March 31, 2019 and December 31, 2018, respectively	—	734
Stockholders' equity (deficit):		
Common stock, $0.001 par value. 33,333,333 and 11,070,776 shares authorized as of March 31, 2019 and December 31, 2018, respectively: 6,724,511 and 351,652 shares issued and outstanding as of March 31, 2019 and December 31, 2018, respectively	7	—
Additional paid-in capital	119,521	2,151
Accumulated other comprehensive income	23	—
Accumulated deficit	(90,110)	(79,237)
Total stockholders' equity (deficit)	29,441	(77,086)
Total liabilities, convertible preferred stock, redeemable common stock and stockholders' equity (deficit)	$ 62,549	$ 9,944

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

X4 PHARMACEUTICALS, INC.

CONDENSED CONSOLIDATED STATEMENTS OF OPERATIONS

(In thousands, except share and per share amounts)

(Unaudited)

	Three Months Ended March 31,	
	2019	**2018**
Operating expenses:		
Research and development	$ 5,655	$ 4,744
General and administrative	4,783	1,366
Total operating expenses	10,438	6,110
Loss from operations	(10,438)	(6,110)
Other income (expense):		
Interest income	69	69
Interest expense	(399)	(169)
Change in fair value of preferred stock warrant liability	(288)	(592)
Change in fair value of derivative liability	183	(565)
Total other income (expense), net	(435)	(1,257)
Net loss	(10,873)	(7,367)
Accruing dividends on Series A convertible preferred stock	(592)	(740)
Net loss attributable to common stockholders	$ (11,465)	$ (8,107)
Net loss per share attributable to common stockholders—basic and diluted	$ (6.67)	$ (17.70)
Weighted average common shares outstanding—basic and diluted	1,717,808	457,971

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

X4 PHARMACEUTICALS, INC.

CONDENSED CONSOLIDATED STATEMENTS OF COMPREHENSIVE LOSS

(In thousands)

(Unaudited)

	Three Months Ended March 31,	
	2019	2018
Net loss	$(10,873)	$(7,367)
Other comprehensive gain		
Currency translation adjustments	23	—
Total comprehensive loss	$(10,850)	$(7,367)

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

X4 PHARMACEUTICALS, INC

CONDENSED CONSOLIDATED STATEMENTS OF CONVERTIBLE PREFERRED STOCK, REDEEMABLE COMMON STOCK AND STOCKHOLDERS' EQUITY (DEFICIT)

(In thousands, except share amounts)

(Unaudited)

	Series Seed, A and B Convertible Preferred		Redeemable Common Stock		Common Stock		Additional Paid-In			Total Stockholders'
	Shares	Amount	Shares	Amount	Shares	Amount	Capital	AOCI	Accumulated Deficit	(Deficit) Equity
Balances at December 31, 2018	40,079,567	$ 64,675	107,364	$ 734	351,652	$ —	$ 2,151	$ —	$ (79,237)	$ (77,086)
Conversion of redeemable common stock into common stock	—	—	(107,364)	(734)	107,364	1	733	—	—	734
Conversion of convertible preferred shares into common stock	(40,079,567)	(64,675)	—	—	3,808,430	4	64,671	—	—	64,675
Exchange of common stock in connection with Merger	—	—	—	—	2,440,582	2	45,539	—	—	45,541
Fair value of replacement equity awards	—	—	—	—	—	—	817	—	—	817
Reclassification of warrant liability to permanent equity	—	—	—	—	—	—	5,235	—	—	5,235
Exercise of stock options	—	—	—	—	16,483	—	113	—	—	113
Stock-based compensation expense	—	—	—	—	—	—	262	—	—	262
Net loss	—	—	—	—	—	—	—	23	(10,873)	(10,850)
Balances at March 31, 2019	—	$ —	—	$ —	6,724,511	$ 7	$119,521	$ 23	$ (90,110)	$ 29,441

	Series Seed, A and B Convertible Preferred		Redeemable Common Stock		Common Stock		Additional Paid-In			Total Stockholders'
	Shares	Amount	Shares	Amount	Shares	Amount	Capital	AOCI	Accumulated Deficit	(Deficit)
Balances at December 31, 2017	38,018,968	$60,903	107,364	$ 734	350,607	$ —	$ 1,385	$ —	$ (45,930)	$ (44,545)
Repurchase of Series Seed convertible preferred stock, net of issuance costs of $1	(598,975)	(517)	—	—	—	—	—	—	(22)	(22)
Stock-based compensation expense	—	—	—	—	—	—	128	—	—	128
Net loss	—	—	—	—	—	—	—	—	(7,367)	(7,367)
Balances at March 31, 2018	37,419,993	$60,386	107,364	$ 734	350,607	$ —	$ 1,513	$ —	$ (53,319)	$ (51,806)

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

X4 PHARMACEUTICALS, INC.

CONDENSED CONSOLIDATED STATEMENTS OF CASH FLOWS

(In thousands)

(Unaudited)

	Three Months Ended March 31,	
	2019	**2018**
Cash flows from operating activities:		
Net loss	$(10,873)	$ (7,367)
Adjustments to reconcile net loss to net cash used in operating activities:		
Stock-based compensation expense	262	128
Depreciation expense	20	26
Non-cash lease expense	119	—
Non-cash interest expense	153	27
Change in fair value of preferred stock warrant liability	288	592
Change in fair value of derivative liability	(183)	565
Changes in operating assets and liabilities:		
Prepaid expenses and other current assets	(595)	170
Accounts payable	1,332	(563)
Accrued expenses	(2,072)	240
Operating lease liabilities	(201)	—
Net cash used in operating activities	(11,750)	(6,182)
Cash flows from investing activities:		
Cash and restricted cash acquired in connection with the Merger	26,406	—
Net cash provided by investing activities	26,406	—
Cash flows from financing activities:		
Proceeds from exercise of stock options	113	—
Repurchase of Series Seed convertible preferred stock	—	(1,126)
Repayments of borrowings under loan and security agreement	—	(500)
Payments of issuance costs of convertible preferred stock	—	(34)
Net cash provided by (used in) financing activities	113	(1,660)
Effect of exchange rate changes on cash, cash equivalents and restricted cash	(21)	—
Net increase (decrease) in cash, cash equivalents and restricted cash	14,748	(7,842)
Cash, cash equivalents and restricted cash at beginning of period	8,498	27,048
Cash, cash equivalents and restricted cash at end of period	$ 23,246	$19,206
Supplemental disclosure of cash flow information:		
Cash paid for interest	$ 243	$ 146
Supplemental disclosure of non-cash investing and financing activities:		
Conversion of convertible preferred stock into common stock	$ 64,675	—
Conversion of redeemable common stock into common stock	$ 734	—
Conversion of convertible preferred stock warrants into common stock warrants	$ 5,235	—
Fair value of net assets acquired in Merger	$ 46,358	—

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

X4 PHARMACEUTICALS, INC.
NOTES TO CONDENSED CONSOLIDATED FINANCIALS STATEMENTS
(Amounts in thousands, except share and per share amounts)
(Unaudited)

1. Nature of the Business and Basis of Presentation

X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc.), together with its subsidiaries (the "Company"), is a clinical-stage biotechnology research and development company focused on the development of novel therapeutics for the treatment of rare diseases. The Company is headquartered in Cambridge, Massachusetts.

The Company is subject to risks and uncertainties common to early-stage companies in the biotechnology industry, including, but not limited to, development by competitors of new technological innovations, dependence on key personnel, protection of proprietary technology, compliance with governmental regulations and the ability to secure additional capital to fund operations. Drug candidates currently under development will require extensive preclinical and clinical testing and regulatory approval prior to commercialization. These efforts require significant amounts of additional capital, adequate personnel, and infrastructure and extensive compliance-reporting capabilities. Even if the Company's drug development efforts are successful, it is uncertain when, if ever, the Company will realize significant revenue from product sales.

The accompanying condensed consolidated financial statements have been prepared in accordance with accounting principles generally accepted in the United States of America ("GAAP") and include the accounts of the Company and its wholly owned subsidiaries. All intercompany accounts and transactions have been eliminated in consolidation.

Merger with Arsanis

On November 26, 2018, Arsanis, Inc., a publicly held Delaware corporation ("Arsanis"), Artemis AC Corp., a Delaware corporation and a wholly owned subsidiary of Arsanis ("Merger Sub"), and X4 Therapeutics, Inc. ("X4") entered into an Agreement and Plan of Merger, as amended on December 20, 2018 and March 8, 2019 (the "Merger Agreement"), pursuant to which the Merger Sub merged with and into X4, with X4 surviving the merger as a wholly owned subsidiary of Arsanis. The transactions described in the foregoing sentence may be referred to in these condensed consolidated financial statements as "the Merger."

The transaction was accounted for as a reverse merger in accordance with GAAP. Under this method of accounting, X4 was deemed to be the accounting acquirer for financial reporting purposes. This determination was primarily based on the facts that, immediately following the Merger: (i) the Company's stockholders own a substantial majority of the voting rights in the combined organization, (ii) the Company designated a majority of the members of the initial board of directors of the combined organization and (iii) the Company's senior management hold all key positions in the senior management of the combined organization. Accordingly, for accounting purposes, the business combination was treated as the equivalent of X4 issuing stock to acquire the net assets of Arsanis. As a result, as of the closing date of the Merger, the net assets of Arsanis were recorded at their acquisition-date fair values in the financial statements of the Company and the reported operating results prior to the business combination will be those of the Company. In addition, transaction costs incurred by the Company in connection with the business combination will be expensed as incurred.

On March 13, 2019, Arsanis, X4 and Merger Sub completed the Merger pursuant to the terms of the Merger Agreement. Pursuant to the terms of the Merger Agreement, each outstanding share of X4's common stock and preferred stock was exchanged for 0.5702 shares of Arsanis's common stock (the "Exchange Ratio"). In addition, all outstanding options exercisable for common stock and warrants exercisable for convertible preferred stock of X4 became options and warrants exercisable for the same number of shares of common stock of Arsanis multiplied by the Exchange Ratio. In connection with the Merger, X4 changed its name to X4 Therapeutics, Inc. Following the closing of the Merger, X4 Therapeutics, Inc. is a wholly owned subsidiary of the Company. which changed its name to X4 Pharmaceuticals, Inc. As used herein, the words "the Company" refers to, for periods following the Merger, X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc.), together with is direct and indirect subsidiaries, and for periods prior to the Merger, X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.), and its direct and indirect subsidiaries, as applicable.

Immediately following the Merger, stockholders of X4 owned approximately 63.7% of the combined organization's outstanding common stock. On March 14, 2019, the combined organization's common stock began trading on The Nasdaq Capital Market under the ticker symbol "XFOR."

Reverse Stock Split

On March 13, 2019, immediately following the closing of the Merger, the Company effected a 6-for-1 reverse stock split of its common stock (the "Reverse Stock Split"). Accordingly, all share and per share amounts for all periods presented in the accompanying condensed consolidated financial statements and notes thereto have been adjusted retroactively, where applicable, to reflect the Reverse Stock Split. No fractional shares were issued in connection with the Reverse Stock Split. Unless otherwise noted, all references to common stock share and per share amounts have also been adjusted to reflect the exchange ratio of 0.5702.

X4 PHARMACEUTICALS, INC.
NOTES TO CONDENSED CONSOLIDATED FINANCIALS STATEMENTS
(Amounts in thousands, except share and per share amounts)
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Going Concern Assessment

In accordance with Accounting Standards Update ("ASU") No. 2014-15, *Disclosure of Uncertainties about an Entity's Ability to Continue as a Going Concern (Subtopic 205-40)* , the Company has evaluated whether there are certain conditions and events, considered in the aggregate, that raise substantial doubt about the Company's ability to continue as a going concern within one year after the date that the consolidated financial statements are issued. As of May 14, 2019, the issuance date of these condensed consolidated financial statements, the Company expects that its cash and cash equivalents, including approximately $79 million of net proceeds from the public sale of common stock, pre-funded warrants and Class A warrants in April 2019, will be sufficient to fund its forecasted operating expenses, capital expenditure requirements and debt service payments for at least the next twelve months from the issuance of these financial statements. The future viability of the Company beyond that point is dependent on its ability to raise additional capital to finance its operations.

If the Company is unable to obtain funding, the Company will be forced to delay, reduce or eliminate some or all of its research and development programs, product portfolio expansion or pre-commercialization efforts, which could adversely affect its business prospects, or the Company may be unable to continue operations. Although management continues to pursue these plans, there is no assurance that the Company will be successful in obtaining sufficient funding on terms acceptable to the Company to fund continuing operations, if at all.

2. Summary of Significant Accounting Policies

Unaudited Interim Financial Statements

The condensed balance sheet at December 31, 2018 was derived from audited financial statements but does not include all disclosures required by GAAP. The accompanying condensed consolidated financial statements are unaudited. The accompanying unaudited interim consolidated financial statements have been prepared by the Company pursuant to the rules and regulations of the Securities and Exchange Commission (the "SEC") for interim financial statements. Accordingly, certain information and footnote disclosures normally included in financial statements prepared in accordance with GAAP have been condensed or omitted pursuant to such rules and regulations. However, the Company believes that the disclosures are adequate to make the information presented not misleading. These unaudited condensed financial statements should be read in conjunction with the Company's audited financial statements and the notes thereto for the year ended December 31, 2018. In the opinion of management, all adjustments, consisting only of normal recurring adjustments as necessary, for the fair statement of the Company's condensed financial position, condensed results of its operations and cash flows have been made. The results of operations for the three months ended March 31, 2019 are not necessarily indicative of the results of operations that may be expected for the year ending December 31, 2019.

Use of Estimates

The preparation of the Company's condensed consolidated financial statements in conformity with GAAP requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the consolidated financial statements, and the reported amounts of expenses during the reporting period. Significant estimates and assumptions reflected in these consolidated financial statements include, but are not limited to, the accrual of research and development expenses, the valuation of intangible assets acquired in business combinations, the valuations of common stock prior to the Merger, the valuation of stock options, preferred stock warrants (and the resulting preferred stock warrant liability), derivative instruments (and the resulting derivative liability), and the preferred stock repurchase liability, and valuation of lease liabilities. The Company bases its estimates on historical experience, known trends and other market-specific or other relevant factors that it believes to be reasonable under the circumstances. On an ongoing basis, management evaluates its estimates when there are changes in circumstances, facts and experience. Changes in estimates are recorded in the period in which they become known. Actual results could differ from those estimates.

Principles of Consolidation

The condensed consolidated financial statements include the accounts of the Company and its wholly owned subsidiaries, including Arsanis Biosciences GmbH, which is incorporated in Vienna, Austria ("Arsanis GmbH"), and X4 Therapeutics, Inc. All significant intercompany accounts and transactions have been eliminated.

Foreign Currency and Currency Translation

Management has determined that the functional currency for the Company's wholly owned foreign subsidiary, Arsanis Biosciences GmbH, is the Euro. Management's assessment considered the currency environment in which the entity operates, including inflows of

X4 PHARMACEUTICALS, INC.
NOTES TO CONDENSED CONSOLIDATED FINANCIALS STATEMENTS
(Amounts in thousands, except share and per share amounts)
(Unaudited)

cash from research and development incentive programs and outflows of cash for operating expenditure. Accordingly, the assets and liabilities of Arsanis Biosciences GmbH are translated from the Euro into United States dollars at the exchange rate in effect on the balance sheet date and income and expenses are translated at the average exchange rate in effect during the period. Unrealized translation gains and losses are recorded as a cumulative translation adjustment, which is included in the consolidated balance sheet as a component of accumulated other comprehensive income (loss). Adjustments that arise from exchange rate changes on transactions denominated in a currency other than the Euro are included in other income (expense), net in the consolidated statements of operations as incurred.

Concentrations of Credit Risk and Significant Suppliers

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

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

Cash and Cash Equivalents

The Company considers all highly liquid investments with maturities of three months or less at the date of purchase to be cash equivalents. Cash equivalents consisted of money market funds as of March 31, 2019 and December 31, 2018.

Restricted Cash

In connection with the Company's lease agreement entered into January 2017 for its facility in Cambridge, Massachusetts, the Company maintains a letter of credit of $264 for the benefit of the landlord. As of March 31, 2019 and December 31, 2018, the underlying cash balance securing this letter of credit was classified as restricted cash (non-current) on its condensed consolidated balance sheets.

The Company also maintains letters of credit for the benefit of the landlords in connection with the Company's office, laboratory, parking and storage space leases in Waltham, MA and Vienna, Austria and another letter of credit in connection with Company's corporate credit cards. As of March 31, 2019, long term restricted cash consisted of letters of credit related to the Company's leases of office, laboratory, parking and storage space lease in Vienna, Austria, of $283 and leased office space acquired from Arsanis located in Waltham, MA, which expires on December 31, 2023, of approximately $250.

As of March 31, 2019, the Company was also required to maintain a separate cash balance of $150 to collateralize corporate credit cards with a bank, which was classified as restricted cash (non-current) on its consolidated balance sheets.

Property and Equipment

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

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

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

X4 PHARMACEUTICALS, INC.
NOTES TO CONDENSED CONSOLIDATED FINANCIALS STATEMENTS
(Amounts in thousands, except share and per share amounts)
(Unaudited)

Right-of-Use Assets and Leases

Effective January 1, 2019, the Company adopted Accounting Standards Codification ("ASC"), Topic 842, *Leases* ("ASC 842"), using the modified retrospective approach through a cumulative-effect adjustment and utilizing the effective date as its date of initial application, with prior periods unchanged and presented in accordance with the guidance in Topic 840, *Leases* ("ASC 840").

At the inception of an arrangement, the Company determines whether the arrangement is or contains a lease based on the unique facts and circumstances present. Leases with a non-cancellable term greater than one year are recognized on the balance sheet as right-of-use assets, lease liabilities and long-term lease liabilities. The Company has elected not to recognize on the balance sheet leases with terms of one year or less. Options to renew a lease are not included in the Company's initial lease term assessment unless there is reasonable certainty that the Company will renew.

Operating lease liabilities and their corresponding right-of-use assets are recorded based on the present value of lease payments over the expected remaining lease term. However, certain adjustments to the right-of-use operating asset may be required for items, such as incentives received. The interest rate implicit in lease contracts is typically not readily determinable. As a result, the Company utilizes its incremental borrowing rates, which are the rates it incurs to borrow on a collateralized basis over a similar term an amount equal to the lease payments in a similar economic environment.

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

Impairment of Long-Lived Assets

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

Goodwill

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

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

The Company assesses qualitative factors to determine whether the existence of events or circumstances would indicate that it is more likely than not that the fair value of the reporting unit was less than its carrying amount. If after assessing the totality of events or circumstances, the Company were to determine that it is more likely than not that the fair value of the reporting unit is less than its carrying amount, then the Company would perform a quantitative impairment test.

The Company compares the fair value of the reporting unit to its carrying value. If the fair value of the reporting unit exceeds the carrying value of the net assets, goodwill is not impaired, and no further testing is required. If the fair value of the reporting unit is less than the carrying value, the Company measures the amount of impairment loss, if any, as the excess of the carrying value over the fair value of the reporting unit. The Company has determined there were no indicators of goodwill impairment as of March 31, 2019.

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Intangible Assets

The Company acquired certain in-process research and development assets ("IPR&D"), which are classified as indefinite-lived intangible assets. Acquired IPR&D represents the fair value assigned to research and development assets that the Company acquires and have not been completed at the acquisition date. The fair value of IPR&D acquired in a business combination is capitalized on the Company's consolidated balance sheets at the acquisition-date fair value and is determined by estimating the costs to develop the technology into commercially viable products, estimating the resulting revenue from the projects, and discounting the projected net cash flows to present value. IPR&D is not amortized, but rather is reviewed for impairment on an annual basis or more frequently if indicators of impairment are present, until the project is completed or abandoned. If the Company determines that IPR&D becomes impaired or is abandoned, the carrying value is written down to its fair value with the related impairment charge recognized in the Company's consolidated statement of operations in the period in which the impairment occurs. Upon successful completion of each project and launch of the product, the Company will make a separate determination of the estimated useful life of the IPR&D intangible asset and the related amortization will be recorded as an expense prospectively over its estimated useful life.

The projected discounted cash flow models used to estimate the Company's IPR&D reflect significant assumptions regarding the estimates a market participant would make in order to evaluate a drug development asset, including the following:

- Probability of successfully completing clinical trials and obtaining regulatory approval;
- Market size, market growth projections, and market share;
- Estimates regarding the timing of and the expected costs to advance the Company's clinical programs to commercialization;
- Estimates of future cash flows from potential product sales; and
- A discount rate.

Additionally, to the extent the Company acquire other indefinite-lived intangible assets through its business combinations, these assets are reviewed for impairment on an annual basis or more frequently if indicators of impairment are present. If the Company determines that the asset becomes impaired, the carrying value is written down to its fair value with the related impairment charge recognized in its consolidated statements of operations in the period in which the impairment occurs.

Deferred Rent

The Company's lease agreements include payment escalations and lease incentives (including a leasehold improvement tenant allowance). For periods prior to January 1, 2019, these payments were accrued or deferred as appropriate such that rent expense was recognized on a straight-line basis over the respective lease terms. Effective January 1, 2019, upon the adoption of ASC 842, deferred rent was reclassified as a reduction to the applicable right-of-use asset as further described in Note 8.

Fair Value Measurements

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

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

Prior to the Merger, the Company's preferred stock warrant liability, derivative liability and preferred stock repurchase liability were carried at fair value, determined according to Level 3 inputs in the fair value hierarchy described above (See Note 4). The Company's cash equivalents, consisting of money market funds invested in U.S. Treasury securities, are carried at fair value, determined based on Level 2 inputs in the fair value hierarchy described above (see Note 4). The carrying values of the Company's accounts payable and accrued expenses approximate their fair values due to the short-term nature of these liabilities. The carrying value of the Company's outstanding loan and security agreement (the "Hercules Loan Agreement") with Hercules Capital, Inc. ("Hercules") approximates its fair value at March 31, 2019 because the debt bears interest at a variable market rate and the Company's credit risk has not materially

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changed since the inception of the agreement. The carrying value of the Company's loans under the funding agreements with Österreichische Forschungsförderungsgesellschaft mbH ("FFG") were recorded at fair value on the opening balance sheet of Arsanis as of the date of the Merger, and approximates the fair value of the loans at March 31, 2019. (See Note 3).

Segment Information

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

Revenue Recognition

Effective January 1, 2018, the Company adopted ASC Topic 606, Revenue from Contracts with Customers ("ASC 606"), using the modified retrospective transition method. The modified retrospective method requires that the cumulative effect of initially applying ASC 606 be recognized as an adjustment to the opening balance of retained earnings or accumulated deficit of the annual period that includes the date of initial application. The Company did not have any arrangements that were in the scope of ASC 606 on January 1, 2018 and thus there was no impact to the condensed consolidated financial statements as a result of the adoption. This standard applies to all contracts with customers, except for contracts that are within the scope of other standards, such as collaboration arrangements and leases. Prior to completion of the Merger, Arsanis entered into a single out-licensing agreement with Janssen Pharmaceuticals, Inc. (see Note 13) that was within the scope of ASC 606.

Research and Development Programs

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

Research and Development Costs

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

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

Upfront payments, milestone payments and annual maintenance fees under license agreements are expensed in the period in which they are incurred.

Patent Costs

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

Debt Issuance Costs

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

Stock-Based Compensation

The Company measures all stock-based awards granted to employees and directors based on the fair value on the date of the grant and recognizes compensation expense for those awards, net of estimated forfeitures, over the requisite service period, which is generally the vesting period of the respective award. The Company issues stock-based awards with only service-based vesting conditions and records the expense for these awards using the straight-line method. The Company has not issued any stock-based awards with performance-based vesting conditions.

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Effective January 1, 2019, the Company adopted ASU No. 2018-07, Compensation—Stock Compensation (Topic 718): Improvements to Nonemployee Share-Based Payment Accounting ("ASU 2018-07"), which expands the scope of Topic 718 to include share-based payment awards to nonemployees. As a result, stock-based awards granted to consultants and non-employees are accounted for in the same manner as awards granted to employees and directors as described above. The impact of adoption this new guidance did not have a material impact on the Company's consolidated financial statements. Prior to the adoption of ASU 2018-07, for stock-based awards granted to non-employee consultants, compensation expense was recognized over the period during which services were rendered by such non-employee consultants until completed. At the end of each financial reporting period prior to completion of the service, the fair value of these awards was remeasured using the then-current fair value of the Company's common stock and updated assumption inputs in the Black-Scholes option-pricing model.

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

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

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

Preferred Stock Warrant Liability

Prior to the Merger with Arsanis, the Company classified warrants for the purchase of shares of its convertible preferred stock (see Note 10) as a liability on its consolidated balance sheets as these warrants are freestanding financial instruments that may have required the Company to transfer assets upon exercise. The warrant liability, which consisted of warrants for the purchase of Series A and Series B convertible preferred stock, was initially recorded at fair value upon the date of issuance of each warrant and is subsequently remeasured to fair value at each reporting date. Changes in the fair value of the warrant liability are recognized as a component of other income (expense), net in the consolidated statement of operations and comprehensive loss. Concurrent with the closing of the Merger, all X4 preferred stock was converted to Arsanis common stock and the X4 preferred stock warrants converted to warrants for the purchase of Arsanis common stock. The Company assessed the features of the warrants and determined that they qualify for classification as permanent equity. Accordingly, the Company remeasured the warrants to fair value upon the closing of the Merger and reclassified the resulting warrant liability to additional paid-in capital. (see Note 10).

Derivative Liability

The Company's license agreement with Genzyme Corporation ("Genzyme") (see Note 13) contained a contingent payment obligation that required the Company to make a cash payment to Genzyme upon a change of control event of the Company. The contingent payment obligation met the definition of a derivative instrument as the contingent payment obligation was not clearly and closely related to its host instrument and was a cash-settled liability. Accordingly, the Company classified this derivative as a liability within other liabilities (non-current) on its condensed consolidated balance sheet. The derivative liability was initially recorded at fair value on the date of entering into the license agreement and was subsequently remeasured to fair value at each reporting date. Changes in the fair value of this derivative liability were recognized as a component of other income (expense), net in the condensed consolidated statement of operations and comprehensive loss. The Merger with Arsanis (see Note 1) qualified as a change of control event, as defined in the license agreement, but resulted in no payment being due to Genzyme under the license agreement. As a result, on March 13, 2019, the closing date of the Merger with Arsanis, the derivative liability was remeasured to fair value, which was $0, and subsequent changes in fair value will no longer be recognized in the consolidated statements of operations and comprehensive loss because the contingent payment obligation to Genzyme expired at that time.

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In addition, the Company's Hercules loan (see Note 7) contains a redemption feature that, upon an event of default, provides Hercules the option to accelerate and demand repayment of the debt, including a prepayment premium. The redemption feature meets the definition of a derivative instrument as the repayment of the debt contains a substantial premium, resulting in the redemption feature not being clearly and closely related to its host instrument. Accordingly, the Company classifies this derivative as a liability within other liabilities (non-current) on its condensed consolidated balance sheet. The derivative liability was initially recorded at fair value on the date of entering into the Hercules Loan Agreement and is subsequently remeasured to fair value at each reporting date. Changes in the fair value of this derivative liability are recognized as a component of other income (expense), net in the condensed consolidated statement of operations and comprehensive loss. Changes in the fair value of this derivative liability will continue to be recognized until all amounts outstanding under the Hercules Loan Agreement are repaid or until the Hercules Loan Agreement is terminated.

Comprehensive Loss

Comprehensive loss includes net loss as well as other changes in stockholders' equity (deficit) that result from transactions and economic events other than those with stockholders. For the three months ended March 31, 2019, comprehensive loss included $23 of foreign currency translation gain adjustments.

Income Taxes

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

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

Net Income (Loss) per Share

The Company follows the two-class method when computing net income (loss) per share as the Company has issued shares that meet the definition of participating securities. The two-class method determines net income (loss) per share for each class of common and participating securities according to dividends declared or accumulated and participation rights in undistributed earnings. The two-class method requires income available to common stockholders for the period to be allocated between common and participating securities based upon their respective rights to receive dividends as if all income for the period had been distributed.

Basic net income (loss) per share attributable to common stockholders is computed by dividing the net income (loss) attributable to common stockholders by the weighted average number of common shares outstanding for the period. Diluted net income (loss) attributable to common stockholders is computed by adjusting net income (loss) attributable to common stockholders to reallocate undistributed earnings based on the potential impact of dilutive securities. Diluted net income (loss) per share attributable to common stockholders is computed by dividing the diluted net income (loss) attributable to common stockholders by the weighted average number of common shares outstanding for the period, including potential dilutive common shares. For purpose of this calculation, outstanding stock options, convertible preferred stock and warrants to purchase shares of convertible preferred stock are considered potential dilutive common shares.

The Company's convertible preferred stock contractually entitles the holders of such shares to participate in dividends but does not contractually require the holders of such shares to participate in losses of the Company. Accordingly, in periods in which the Company reports a net loss attributable to common stockholders, such losses are not allocated to such participating securities. In periods in which the Company reports a net loss attributable to common stockholders, diluted net loss per share attributable to common stockholders is the same as basic net loss per share attributable to common stockholders, since dilutive common shares are not assumed to have been issued if their effect is anti-dilutive. The Company reported a net loss attributable to common stockholders for the three months ended March 31, 2019 and 2018.

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Recently Adopted Accounting Pronouncements

In February 2016, the FASB issued ASU No. 2016-02*, Leases (Topic 842)* ("ASU 2016-02" or "ASC 842")), which sets out the principles for the recognition, measurement, presentation and disclosure of leases for both parties to a contract (i.e., lessees and lessors). The new standard requires lessees to apply a dual approach, classifying leases as either finance or operating leases based on the principle of whether or not the lease is effectively a financed purchase by the lessee. This classification will determine whether lease expense is recognized based on an effective interest method or on a straight-line basis over the term of the lease. A lessee is also required to record a right-of-use asset and a lease liability for all leases with a term of greater than 12 months regardless of their classification. Leases with a term of 12 months or less may be accounted for similar to prior guidance for operating leases. The Company adopted the new leasing standard as of the required effective date of January 1, 2019 using a modified retrospective transition approach to be applied to leases existing as of, or entered into after, January 1, 2019. The adoption had no impact on accumulated deficit. The new lease standard provides a number of optional practical expedients in transition. The Company applied the package of practical expedients to leases that commenced prior to the effective date, whereby it will elect to not reassess the following: (i) whether any expired or existing contracts contain leases; (ii) the lease classification for any expired or existing leases; and (iii) initial direct costs for any existing leases. The Company also elected the short-term lease recognition exemption for all leases that qualify, where a right-of-use asset or lease liability will not be recognized for short-term leases. Upon the adoption of ASC 842, the Company recorded $2.5 million of operating lease liabilities and $2.0 million of right-of-use assets on its consolidated balance. The adoption did not have a material impact on the Company's statement of operations, statement of comprehensive loss or statement of cash flows.

In January 2017, the FASB issued ASU No. 2017-04, *Intangibles-Goodwill and Other (Topic 350): Simplifying the Test for Goodwill Impairment.* The new standard simplifies the subsequent measurement of goodwill by eliminating the second step of the goodwill impairment test. This ASU will be applied prospectively and is effective for annual or interim goodwill impairment tests in fiscal years beginning after December 15, 2019 with early adoption permitted. The Company has adopted this guidance on January 1, 2019 and will apply it to its annual impairment test, and any interim impairment tests during the year ending December 31, 2019.

In April 2017, the FASB issued ASU 2017-08, *Receivables – Nonrefundable Fees and Other Costs* ("Subtopic 310-20"). The new standard amends the amortization period for certain purchased callable debt securities held at a premium by shortening the amortization period for the premium to the earliest call date. Subtopic 310-20 calls for a modified retrospective application under which a cumulative-effect adjustment will be made to retained earnings as of the beginning of the first reporting period in which the guidance is adopted. The new standard will be effective beginning January 1, 2019 and early adoption is permitted for public entities. The Company adopted this guidance, effective January 1, 2019, and its adoption had no impact on the Company's financial position, results of operations or cash flows.

In July 2017, the FASB issued ASU No. 2017-11, *Earnings Per Share (Topic 260), Distinguishing Liabilities from Equity (Topic 480), Derivatives and Hedging (Topic 815) (Part I) Accounting for Certain Financial Instruments with Down Round Features (Part II) Replacement of the Indefinite Deferral for Mandatorily Redeemable Financial Instruments of Certain Nonpublic Entities and Certain Mandatorily Redeemable Noncontrolling Interests with a Scope Exception* ("ASU 2017-11"). Part I applies to entities that issue financial instruments such as warrants, convertible debt or convertible preferred stock that contain down-round features. Part II replaces the indefinite deferral for certain mandatorily redeemable noncontrolling interests and mandatorily redeemable financial instruments of nonpublic entities contained within ASC Topic 480 with a scope exception and does not impact the accounting for these mandatorily redeemable instruments. For public entities, ASU 2017-11 is effective for annual reporting periods beginning after December 15, 2018, including interim periods within those fiscal years. The Company adopted ASU 2017-11 as of the required effective date of January 1, 2019. The adoption of ASU 2017-11 had no impact on the Company's financial position, results of operations or cash flows.

In June 2018, the FASB issued ASU No. 2018-07, *Compensation—Stock Compensation (Topic 718): Improvements to Nonemployee Share-Based Payment Accounting* ("ASU 2018-07"). These amendments expand the scope of Topic 718, Compensation—Stock Compensation (which previously only included share-based payments to employees) to include share-based payments issued to non-employees for goods or services. Consequently, the accounting for share-based payments to non-employees and employees will be substantially aligned. The ASU supersedes Subtopic 505-50, Equity —*Equity-Based Payments to Non-Employees*. The Company adopted ASU 2018-07 on January 1, 2019. The adoption of this standard had no impact on the Company's financial statements.

Recently Issued Accounting Pronouncements

In August 2018, the FASB issued ASU No. 2018-13, *Fair Value Measurement (Topic 820): Disclosure Framework—Changes to the Disclosure Requirements for Fair Value Measurement* ("ASU 2018-13"), which removes, adds and modifies certain disclosure requirements for fair value measurements in Topic 820. The Company will no longer be required to disclose the amount of and reasons for transfers between Level 1 and Level 2 of the fair value hierarchy as well as the valuation processes of Level 3 fair value

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measurements. However, the Company will be required to additionally disclose the changes in unrealized gains and losses included in other comprehensive income for recurring Level 3 fair value measurements and the range and weighted average of assumptions used to develop significant unobservable inputs for Level 3 fair value measurements. ASU 2018-13 is effective for fiscal years, and interim periods within those fiscal years, beginning after December 15, 2019. The amendments relating to additional disclosure requirements will be applied prospectively for only the most recent interim or annual period presented in the initial year of adoption. All other amendments will be applied retrospectively to all periods presented upon their effective date. The Company is currently evaluating the impact that the adoption of ASU 2018-13 will have on its consolidated financial statements.

In August 2018, the FASB issued ASU 2018-15, *Intangibles-Goodwill and Other-Internal-Use Software (Subtopic 350-40): Customer's Accounting for Implementation Costs Incurred in a Cloud Computing Arrangement That Is a Service Contract, ("ASU 2018-15")*. The amendments in this update align the requirements for capitalizing implementation costs incurred in a hosting arrangement that is a service contract with the requirements for capitalizing implementation costs incurred to develop or obtain internal-use software (and hosting arrangements that include an internal-use software license). The accounting for the service element of a hosting arrangement that is a service contract is not affected by the amendments in this update. The new standard will be effective beginning January 1, 2020 and early adoption is permitted. The amendments in this update should be applied either retrospectively or prospectively to all implementation costs incurred after the date of adoption. The Company is currently evaluating the impact that the adoption of ASU 2018-15 will have on its consolidated financial statements.

3. Merger Accounting

Based on the Exchange Ratio of 0.5702, immediately following the Merger, former Arsanis stockholders, Arsanis option holders and other persons holding securities or other rights directly or indirectly convertible, exercisable or exchangeable for Arsanis common stock owned approximately 31.3% of the outstanding capital stock of the combined organization on a fully diluted basis, and former X4 stockholders, holders of options or warrants to acquire X4 capital stock and other persons holding securities and other rights directly or indirectly convertible, exercisable or exchangeable for X4 capital stock owned approximately 68.7% of the outstanding capital stock of the combined organization on a fully diluted basis. At the closing of the Merger, all shares of X4 common stock and X4 preferred stock then outstanding were exchanged for Arsanis common stock.

In addition, pursuant to the terms of the Merger Agreement, the Company, for accounting purposes, assumed all outstanding stock options to purchase shares of Arsanis common stock at the closing of the Merger. At the closing of the Merger, such stock options became options to purchase an aggregate of 271,230 shares of the Company's common stock after giving effect to the Reverse Stock Split.

The total purchase price paid in the Merger has been allocated to the tangible and intangible assets acquired and liabilities assumed of Arsanis based on their fair values as of the completion of the Merger, with the excess allocated to goodwill. The following summarizes the preliminary estimate of the purchase price paid in the Merger:

Number of shares of the combined organization owned by Arsanis stockholders (1)	2,440,582
Multiplied by the fair value per share of Arsanis common stock (2)	$ 18.66
Fair value of consideration issued it effect the Merger	$ 45,541
Fair value of replacement awards held by former employees, board of directors and consultants of Arsanis that were vested as of the Merger.	$ 817
Purchase price:	$ 46,358

(1) The number of shares of 2,440,582 represents the historical 14,643,737 shares of Arsanis common stock outstanding immediately prior to the closing of the Merger, adjusted for the Reverse Stock Split.
(2) Based on the last reported sale price of Arsanis common stock on the Nasdaq Global Market on March 13, 2019, the closing date of the Merger, and gives effect to the Reverse Stock Split.

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The following summarizes the allocation of the purchase price to the net tangible and intangible assets acquired:

Cash and cash equivalents and restricted cash	$ 26,406
Other current assets	2,147
Property and equipment, net	68
IPR&D indefinite-lived intangible assets	4,900
Other assets, non-current	879
Current liabilities	(5,221)
Loans payable	(8,713)
Other liabilities, non-current	(1,515)
Goodwill	27,407
Purchase price	$ 46,358

The goodwill of $27,407 is not tax deductible and represents the excess of the consideration paid over the fair value of assets acquired and liabilities assumed. Goodwill is mainly attributable to the enhanced value of the combined company, as reflected in the increase in market value of the Arsanis common shares following the announcement of the Merger with X4. The Company incurred costs directly related to the Merger of approximately $1 million for the three months ended March 31, 2019.

The preliminary allocation of the purchase price for the Merger was based on estimates of the fair value of the net assets acquired and is subject to adjustment upon finalization of the valuation of the acquired intangible assets, property, plant and equipment, right-of-use assets, lease obligations, fair value of debt and any related deferred taxes. Measurements of these items inherently require significant estimates and assumptions.

The following supplemental unaudited pro forma information presents the Company's financial results as if the acquisition of Arsanis had occurred on January 1, 2018:

	Three Months Ended March 31,	
	2019	2018
	(unaudited)	
Revenue	$ 0	$ 0
Net loss	$(16,258)	$(20,235)

The above unaudited pro forma information was determined based on the historical GAAP results of the Company and Arsanis. The unaudited pro forma consolidated results are not necessarily indicative of what the Company's consolidated results of operations would have been if the acquisition was completed on January 1, 2018. The unaudited pro forma consolidated net loss includes pro forma adjustments primarily relating to the reclassification of transaction costs and severance payments directly related to the closing of the Merger of $2.7 million from the three months ended March 31, 2019 to the three months ended March 31, 2018.

4. Fair Value of Financial Assets and Liabilities

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

	Fair Value Measurements as of March 31, 2019 Using:			
	Level 1	Level 2	Level 3	Total
Assets:				
Cash equivalents—money market funds	$ —	$ 22,299	$ —	$ 22,299
	$ —	$ 22,299	$ —	$ 22,299
Liabilities:				
Preferred stock warrant liability	$ —	$ —	$ —	$ —
Derivative liability	—	—	18	$ 18
	$ —	$ —	$ 18	$ 18

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	Fair Value Measurements as of December 31, 2018 Using:			
	Level 1	Level 2	Level 3	Total
Assets:				
Cash equivalents—money market fund	$ —	$ 8,134	$ —	$ 8,134
	$ —	$ 8,134	$ —	$ 8,134
Liabilities:				
Preferred stock warrant liability	$ —	$ —	$ 4,947	$ 4,947
Derivative liability	—	—	201	$ 201
	$ —	$ —	$ 5,148	$ 5,148

As of March 31, 2019 and December 31, 2018, there were no transfers between Level 1, Level 2 and Level 3.

The Company's cash equivalents consisted of a money market fund invested in U.S. Treasury securities. The money market fund was valued using inputs observable in active markets for similar securities, which represents a Level 2 measurement in the fair value hierarchy.

Valuation of Preferred Stock Warrant Liabilities

The preferred stock warrant liability in the table above consists of the fair values of (i) warrants to purchase shares of Series A convertible preferred stock that were issued in 2015 and shares of Series B convertible preferred stock that were issued in 2017 and 2018 in connection with the Company's Series A and Series B convertible preferred stock financings, respectively (see Notes 10), (ii) warrants to purchase shares of Series A convertible preferred stock that were issued in 2016 in connection with the Company's entering into a loan and security agreement with Silicon Valley Bank (see Note 7) and (iii) warrants to purchase shares of Series B convertible preferred stock that were issued or were issuable in 2018 in connection with the Company's entering into the Hercules Loan Agreement (see Note 7). The liability associated with the warrants was recorded at fair value on the dates the warrants were issued and exercisable and was subsequently remeasured to fair value at each reporting date through December 31, 2018. Upon the closing of the Merger, all X4 preferred stock warrants were converted to warrants for Company's common stock and, as a result, the warrants were adjusted to fair value and reclassified to permanent equity. The aggregate fair value of the warrant liability was determined based on significant inputs not observable in the market, which represents a Level 3 measurement within the fair value hierarchy.

The Company used various valuation methods, including the Monte Carlo method, the option-pricing method and the hybrid method (which is a combination of an option-pricing method and a probability-weighted expected return method), all of which incorporate assumptions and estimates, to value the preferred stock warrants. Estimates and assumptions impacting the fair value measurement include the fair value per share of the underlying shares of the Company's Series A and Series B convertible preferred stock, risk free interest rate, expected dividend yield, expected volatility of the price of the underlying preferred stock, and either the remaining contractual term of the warrants (except for warrants that would be automatically exercised upon an initial public offering, in which case the remaining estimated term to automatic exercise was used). The most significant assumption in the Monte Carlo method, the option-pricing method and the hybrid method impacting the fair value of the preferred stock warrants is the fair value of the Company's convertible preferred stock as of each remeasurement date. The Company determines the fair value per share of the underlying preferred stock by taking into consideration the most recent sales of its convertible preferred stock, results obtained from third-party valuations and additional factors that are deemed relevant. As of December 31, 2018, the fair value of the Series A convertible preferred stock was $1.70 per share the fair value of the Series B convertible preferred stock was $1.86 per share. There were no warrants for the purchase of convertible preferred shares as of March 31, 2019 as all such warrants were converted to warrants for the purchase of common stock upon the Merger. The Company has been a private company prior to the Merger and lacks company-specific historical and implied volatility information of its stock. Therefore, it estimates its expected stock volatility based on the historical volatility of publicly traded peer companies for a term equal to the estimated remaining term of the warrants. The risk-free interest rate is determined by reference to the U.S. Treasury yield curve for time periods approximately equal to the estimated remaining term of the warrants. The Company estimated a 0% expected dividend yield based on the fact that the Company has never paid or declared dividends and does not intend to do so in the foreseeable future.

Valuation of Derivative Liability

The fair value of the derivative liability recognized in connection with the Company's July 2014 license agreement with Genzyme (see Note 13) was determined based on significant inputs not observable in the market, which represents a Level 3 measurement within the fair value hierarchy. The fair value of this derivative liability is reported within other liabilities on the consolidated balance

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sheets. The fair value of this derivative liability was estimated by the Company at each reporting date based, in part, on the results of third-party valuations, which were prepared using the option-pricing method or the hybrid method, each of which considered as inputs the type, timing and probability of occurrence of a change of control event, the potential amount of the payment under potential exit scenarios, the fair value per share of the underlying common stock and the risk-adjusted discount rate. As of December 31, 2018, the fair value of this derivative liability was $183. The Merger with Arsanis (see Note 1) qualified as a change of control event, as defined in the license agreement, but results in no payment being due to Genzyme under the license agreement. As a result, on March 13, 2019, the closing date of the Merger with Arsanis, this derivative liability was remeasured to fair value, which was $0, and subsequent changes in fair value will no longer be recognized in the consolidated statements of operations and comprehensive loss because the contingent payment obligation to Genzyme expired at that time.

The fair value of the derivative liability recognized in connection with the Hercules Loan Agreement (see Note 7) was determined based on significant inputs not observable in the market, which represents a Level 3 measurement within the fair value hierarchy. The fair value of this derivative liability is reported within other liabilities on the consolidated balance sheets. The fair value of this derivative liability was estimated by the Company at each reporting date based, in part, on the results of third-party valuations, which were prepared based on a discounted cash flow model that considered the timing and probability of occurrence of a redemption upon an event of default, the potential amount of prepayment upon an event of default and the risk-adjusted discount rate. As of March 31, 2019 and December 31, 2018, the fair value of this derivative liability was immaterial.

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

	Preferred Stock Warrant Liability	Derivative Liability
Balance as of December 31, 2018	$ 4,947	$ 201
Change in fair value	288	(183)
Conversion of convertible preferred stock warrant into common stock warrant in connection with Merger	(5,235)	—
Balance as of March 31, 2019	$ —	$ 18

5. Property and Equipment, Net

Property and equipment, net consisted of the following:

	March 31, 2019	December 31, 2018
Leasehold improvements	$ 299	$ 299
Furniture and fixtures	53	53
Computer equipment	19	56
Software	9	9
Lab equipment	67	—
	448	417
Less: Accumulated depreciation and amortization	(177)	(176)
	$ 271	$ 241

Depreciation and amortization expense related to property and equipment was $20 and $26 for the three months ended March 31, 2019 and 2018, respectively.

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6. Accrued Expenses

Accrued expenses consisted of the following:

	March 31, 2019	December 31, 2018
Accrued employee compensation and benefits	$ 1,239	924
Accrued external research and development expenses	819	754
Accrued professional fees	1,850	1,324
Deferred rent, current portion	—	93
Other	271	156
	$ 4,179	$ 3,251

7. Long-Term Debt

Long-term debt consisted of the following:

	March 31, 2019	December 31, 2018
Principal amount of long-term debt	$ 19,546	$ 10,000
Less: Current portion of long-term debt	(5,298)	(1,687)
Long-term debt, net of current portion	14,248	8,313
Debt discount, net of accretion	(1,019)	(226)
Cumulative accretion of final payment due at maturity	136	58
Long-term debt, including accretion, net of current portion	$ 13,365	$ 8,145

SVB Loan Agreement

In October 2016, the Company entered into a loan and security agreement with Silicon Valley Bank ("SVB"), which the Company refers to as the SVB Loan Agreement, pursuant to which SVB made certain term loans available to the Company. The SVB Loan Agreement provided for a term loan of up to $6,000, which was borrowed by the Company in June 2017. Borrowings under the SVB Loan Agreement bore interest at a variable rate equal to 5.5% plus the greater of (i) 3.5% or (ii) The Wall Street Journal prime rate. In October 2018, in connection with entering into the Hercules Loan Agreement, the Company terminated the SVB Loan Agreement and repaid all amounts due under the SVB Loan Agreement, including unpaid principal of $4,333, a final payment of $270, a prepayment premium of $87 and accrued interest of $23. The Company accounted for the repayment of amounts as an extinguishment of the SVB Loan Agreement and recognized a loss on extinguishment of debt of $229 within other income (expense), net in the consolidated statement of operations and comprehensive loss. The loss on extinguishment of debt was calculated as the difference between the reacquisition price of the borrowings under the SVB Loan Agreement of $4,713 and the carrying value of the debt under the SVB Loan Agreement of $4,484. As of October 19, 2018, the date of repayment of all borrowings under the SVB Loan Agreement, the interest rate applicable to borrowings under the SVB Loan Agreement was 10.75%.

Hercules Loan Agreement

In October 2018, the Company entered into the Hercules Loan Agreement, which provided for aggregate borrowings of up to $13,000, consisting of (i) a term loan of up to $8,000, which was available upon entering into the agreement, (ii) subject to specified financing conditions, an additional term loan of up to $2,000, available for borrowing from January 1, 2019 to March 31, 2019, and (iii) subject to specified financing conditions and the receipt of the second tranche $2,000 term loan described above, an additional term loan of up to $3,000, available for borrowing until March 31, 2019. In October 2018, the Company borrowed $8,000 under the Hercules Loan Agreement.

In December 2018, the Company entered into the First Amendment to the Hercules Loan Agreement (the "First Amendment"), which amended the available borrowing dates of the second tranche from between January 1, 2019 and March 31, 2019 to between December 11, 2018 and December 14, 2018 and amended the term loan maturity date to November 1, 2021. In December 2018, the Company borrowed the additional $2,000 provided under the Hercules Loan Agreement, as amended by the First Amendment.

In March 2019, the conditions necessary for borrowing the remaining $3,000 under the Hercules Loan Agreement were not met and the borrowing capacity expired at that time.

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Borrowings under the Hercules Loan Agreement bear interest at variable rates, with the first tranche bearing interest at a variable rate equal to the greater of (i) 9.5% or (ii) 9.5% plus *The Wall Street Journal* prime rate minus 5.25%, the second tranche bearing interest at a variable rate, subject to completion of specified financing conditions, equal to either (A) the greater of (i) 9.5% or (ii) 9.5% plus *The Wall Street Journal* prime rate minus 5.25% or (B) the greater of (i) 8.75% or (ii) 8.75% plus *The Wall Street Journal* prime rate minus 5.25%, and the third tranche bearing interest at a variable rate equal to the greater of (i) 8.75% or (ii) 8.75% plus *The Wall Street Journal* prime rate minus 5.25%. In an event of default, as defined, and until such event is no longer continuing, the interest rate applicable to borrowings under the Hercules Loan Agreement would be increased by 4.0%. As of March 31, 2019 and December 31, 2018, the interest rate applicable to borrowings under the Hercules Loan Agreement was 9.80% and 9.75%.

Borrowings under the Hercules Loan Agreement are repayable in monthly interest-only payments through August 2019, or a later date upon achievement of specified conditions, and in equal monthly payments of principal and accrued interest from September 2019 until the maturity date of the loan, which is November 2021. At the Company's option, the Company may prepay all, but not less than all, of the outstanding borrowings, subject to a prepayment premium of up to 2.0% of the principal amount outstanding as of the date of repayment. The Hercules Loan Agreement also provides for a final payment, payable upon maturity or the repayment in full of all obligations under the agreement, of up to $953. An aggregate final payment of $794 payable in connection with the $8,000 term loan and the $2,000 term loan is being accreted to interest expense to increase the carrying value of the debt over the term of the loan using the effective interest method.

In addition, the Hercules Loan Agreement contains a redemption feature that, upon an event of default, provides Hercules the option to accelerate and demand repayment of the debt, including a prepayment premium. The Company concluded that the redemption feature meets the definition of a derivative instrument as the repayment of the debt contains a substantial premium, resulting in the redemption feature not being clearly and closely related to the host instrument. The Company recorded the issuance-date fair value of the derivative liability of $18 as a debt discount and as a derivative liability on its consolidated balance sheet.

Borrowings under the Hercules Loan Agreement are collateralized by substantially all of the Company's personal property and other assets, including its intellectual property until a specified financing condition is met. Under the Hercules Loan Agreement, the Company has agreed to affirmative and negative covenants to which the Company will remain subject until maturity or repayment in full. The covenants include maintaining a minimum liquidity amount of the lesser of (i) 125% of outstanding borrowings under the Hercules Loan Agreement and (ii) 100% of the Company's cash and cash equivalents in an account in which Hercules has a first priority security interest as well as restrictions on the Company's ability to incur additional indebtedness, pay dividends, encumber its intellectual property, or engage in certain fundamental business transactions, such as mergers or acquisitions of other businesses. Obligations under the Hercules Loan Agreement are subject to acceleration upon occurrence of specified events of default, including payment default, insolvency and a material adverse change in the Company's business, operations or financial or other condition.

In connection with entering into the Hercules Loan Agreement in October 2018, the Company issued to Hercules warrants for the purchase of 210,638 shares of Series B convertible preferred stock at an exercise price of $1.88 per share. These warrants were immediately exercisable and expire in October 2028.

In connection with entering into the First Amendment in December 2018, the Company agreed to issue to Hercules warrants for the purchase of a specified number of shares of convertible preferred stock or, if issued following the Merger with Arsanis, a specified number of shares of common stock of the combined organization, at an aggregate exercise price of $99. The warrants were to be issued at the earliest of (i) June 30, 2019, (ii) the earlier to occur of (a) the date the Company prepays the outstanding borrowings or (b) the date the outstanding borrowings become due and payable, or (iii) on or before the fifth business day following the closing of or the announcement of the termination of the Company's Merger with Arsanis. The number of shares of convertible preferred stock issuable upon exercise of these warrants was determined to be 52,659 shares, calculated by dividing $99 by the $1.88 price per share paid by investors that purchased shares of Series B convertible preferred stock in September 2018 (see Note 11). On March 18, 2019, as a result of the closing of the Merger with Arsanis on March 13, 2019, the Company issued to Hercules warrants for the purchase of 5,000 shares of common stock of the combined organization at an exercise price of $19.80 per share, each of which reflected the share Exchange Ratio of 1-for-0.5702 applied in the Merger as well as the Reverse Stock Split effected by the combined organization on March 13, 2019.

On October 19, 2018 and December 11, 2018, the dates the Company entered into the Hercules Loan Agreement and the First Amendment, respectively, the Company recorded the aggregate initial fair value of the warrants of $132 as a preferred stock warrant liability, with a corresponding amount recorded as a debt discount on the Company's consolidated balance sheet. As of March 13, 2019 and December 31, 2018, the fair value of the warrants was $326 and $282, respectively. Upon the closing of the Merger, the warrants were converted to warrants for common stock and are no longer adjusted to fair value.

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In connection with entering into the Hercules Loan Agreement and the First Amendment, the Company also paid Hercules $92 of upfront fees, including facility, due diligence and legal fees associated with entering into the agreement, which were also recorded as a debt discount. The debt discount is reflected as a reduction of the carrying value of long-term debt on the Company's consolidated balance sheet and is being amortized to interest expense over the term of the loan using the effective interest method.

The Company recognized aggregate interest expense under the Hercules Loan Agreement of $357 and $0 during three months ended March 31, 2019 and 2018, respectively, which included non-cash interest expense of $113 related to the accretion of the debt discount and the final payment. As of March 31, 2019 and December 31, 2018, the unamortized debt discount was $182 and $226, respectively. The Company's annual effective interest rate of the Hercules Loan Agreement as of March 31, 2019 and December 31, 2018 was approximately 14.2%, respectively.

There were no principal payments due or paid under the Hercules Loan Agreement during the three months ended March 31, 2019. Principal payments begin in September 2019.

FFG Loan Agreement

Between September 2011 and March 2017, Arsanis GmbH, a subsidiary of Arsanis, entered into a series of funding agreements with Österreichische Forschungsförderungsgesellschaft mbH ("FFG") that provided for loans and grants to fund qualifying research and development expenditures of Arsanis GmbH on a project-by-project basis, as approved by FFG. Amounts due under the FFG loans bear interest at rates ranging from 0.75% to 2.0% per annum. As of March 31, 2019, giving effect to the Settlement Agreement (as defined below), the loans matured at various dates between March 31, 2019 and March 2021. Interest on amounts due under the loans is payable semi-annually in arrears, with all principal and remaining accrued interest due upon maturity.

As of March 31, 2019, the outstanding principal amount under loans from FFG was $9,546, including $2,914 of current portion.

On March 8, 2019, Arsanis, Merger Sub, X4 and Arsanis GmbH, a wholly owned subsidiary of Arsanis, entered into the Settlement Agreement with FFG (the "Settlement Agreement") in respect to allegations by FFG in February 2019 that Arsanis and Arsanis GmbH breached certain reporting, performance and other obligations in connection with grants and loans made by FFG to Arsanis GmbH between September 2011 and March 2017 to fund qualifying research and development expenditures. Pursuant to the terms of the Settlement Agreement, in exchange for FFG's waiver of all claims against Arsanis and Arsanis GmbH (except for its claims for repayment of the loans and regular interest but including its waiver of claims for repayment of grants and interest exceeding regular interest), subject to compliance by Arsanis and Arsanis GmbH with the terms of the Settlement Agreement, Arsanis GmbH agreed to repay the outstanding loan principal (plus regular interest accrued thereon) on an accelerated payment schedule of three years instead of five years, with the final accelerated installment due and payable on June 30, 2021. The parties also agreed, among other things, that (i) the portion of such loans to be repaid in 2019 is $2,914 on the first business day following March 31, 2019 and (ii) until all of the loans have been repaid and subject to other terms specified in the Settlement Agreement, commencing April 30, 2019, a minimum cash balance equal to 70% of the then-outstanding principal amount of the loans will be maintained at Arsanis GmbH in an account held with an Austrian bank.

As of March 31, 2019, future principal payments and the final payment due under the Company's loan agreements were as follows:

Year Ending December 31,	Hercules	FFG	Total
2019	$ 1,345	$ 2,914	$ 4,259
2020	4,305	4,462	8,767
2021	4,350	2,170	6,520
Long-term debt	$ 10,000	$ 9,546	$19,546

8. Leases

Effective January 1, 2019, the Company adopted ASC 842 using the modified retrospective approach through a cumulative-effect adjustment and utilizing the effective date as its date of initial application, with prior periods unchanged and presented in accordance with the previous lease accounting guidance. Upon adoption, the Company recorded right-of-use assets of $2,026 and lease liabilities of $2,538, of which $1,925 was classified as non-current and $613 as current. The difference between the value of the right-of-use asset and the lease liabilities relates to $512 of net deferred, accrued and prepaid rent that was reclassified against the right-of-use asset upon adoption of ASC 842 on January 1, 2019. The Company has lease agreements for its facilities in Cambridge, Massachusetts, which is the Company's global headquarters, Vienna, Austria, which is the Company's research and development center, and Waltham, Massachusetts, which is the former headquarters of Arsanis. The Company plans to sublease its Waltham, Massachusetts facility. There are no restrictions or financial covenants associated with any of the lease agreements.

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Cambridge Lease

In August 2017, the Company entered into a lease agreement for office space of approximately thirteen thousand square feet in Cambridge, Massachusetts ("Cambridge Lease") which expires on July 31, 2022. The Cambridge lease includes an annual rent escalation clause and the Company has the option to extend the lease for one period of five additional years. Base rent is approximately $810 annually and the monthly rent expense is being recognized on a straight-line basis over the term of the lease. In addition to the base rent, the Company is also responsible for its share of operating expenses, electricity and real estate taxes, in accordance with the terms of lease. These costs are classified as variable lease payments and are not included in the determination of the leases' right-of-use operating assets or lease operating liabilities.

Waltham Lease

On March 13, 2019, as part of its Merger with Arsanis, the Company acquired an operating lease for approximately six thousand square feet of office space in Waltham, Massachusetts ("Waltham Lease"). The Waltham lease, as amended, commenced on January 1, 2019, and expires approximately 5 years from the commencement date. The base rent is approximately $459 annually. In addition to the base rent, the Company is also responsible for its share of operating expenses, electricity and real estate taxes, in accordance with the terms of the Amended Lease Agreement. These costs are classified as variable lease payments and are not included in the determination of the leases' right-of-use assets or lease liabilities.

Vienna Lease

On March 13, 2019, as part of its Merger with Arsanis, the Company acquired an operating lease for approximately four hundred square meters of laboratory and office space in Vienna, Austria, which commenced on March 1, 2019, as amended, for a term of two years. The lease is cancellable by the Company upon three month's notice with no penalty. The annual base rent is approximately $155. The Company has classified this lease as a short-term lease as it is not reasonably certain that the Company with not terminate the lease within one year and, accordingly, has not recorded a right-of-use asset. Accordingly, rent expense is recorded on a straight-line basis as incurred over the term of the lease.

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

The components of lease expense for the three months ended March 31, 2019 were as follows:

Lease Cost	**For the three months ended March 31, 2019**
Fixed operating lease cost	$ 187
Short-term lease costs	8
Total lease expense	$ 195
Other information	
Cash paid for amounts included in the measurement of lease liabilities:	
Operating cash flows from operating leases	$ 201
Leased assets obtained in exchange for new operating lease liabilities (1)	$ 781
Weighted-average remaining lease term—operating leases	3.9 years
Weighted-average discount rate—operating leases	9.0%

(1) Acquired in Merger with Arsanis

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Maturities of lease liabilities due under these lease agreements as of March 31, 2019 are as follows:

Maturity of lease liabilities	Operating Leases
2019 (remainder of 2019)	$ 837
2020	1,281
2021	1,304
2022	970
2023	489
Thereafter	—
Total lease payments	4,880
Less: interest	(764)
Total operating lease liabilities as of March 31, 2019	$ 4,116

The Company adopted ASU 2016-02 on January 1, 2019 as noted above, and as required, the following disclosure is provided for periods prior to adoption. Future annual minimum lease payments due under the Company's operating leases as of December 31, 2018 were as follows:

Year Ending December 31,	Operating Leases
2019	$ 810
2020	823
2021	835
2022	492
Total	$ 2,960

9. Commitment and Contingencies

Sponsored Research Agreement Commitments

In April 2017, the Company entered into a sponsored research agreement with a university that the Company refers to as the Sponsored Research Agreement, pursuant to which the Company and the university intend to conduct a research program related to understanding the mechanisms of failed long-term adaptive immunity in WHIM patients. Under the terms of the Sponsored Research Agreement, the Company agreed to provide funding for the research program of up to $499 over a three-year period. The Sponsored Research Agreement will remain in effect for three years, unless earlier terminated in the event that (i) either party materially breaches any representation, obligation or covenant and fails to remedy such breach within 30 days after receipt of notice or (ii) the Principal Investigator, as defined in the agreement, is unable or unwilling to conduct the research or perform his or her obligations under the agreement, at which time the Company may terminate the agreement upon 30 days' prior written notice to the university. The Company may terminate the agreement at any time upon at least 60 days' prior written notice.

During the three months ended March 31, 2019 and 2018, the Company incurred $42, respectively, of research and development expenses related to its payment obligations to the university under the Sponsored Research Agreement. As of March 31, 2019, the Company had non-cancelable purchase commitments under this agreement totaling $181, with $125 committed in 2019 and $56 committed in 2020.

Manufacturing Commitments

As of March 31, 2019, the Company entered into agreements with several contract manufacturing organizations to provide preclinical and clinical trial materials. As of March 31, 2019, and December 31, 2018, the Company had non-cancelable purchase commitments under these agreements totaling approximately $250, all committed in 2019.

Indemnification Agreements

In the ordinary course of business, the Company may provide indemnification of varying scope and terms to vendors, lessors, business partners and other parties with respect to certain matters including, but not limited to, losses arising out of breach of such agreements

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or from intellectual property infringement claims made by third parties. In addition, the Company has entered into indemnification agreements with members of its board of directors and its executive officers that will require the Company to, among other things, indemnify them against certain liabilities that may arise by reason of their status or service as directors or officers. The maximum potential amount of future payments the Company could be required to make under these indemnification agreements is, in many cases, unlimited. To date, the Company has not incurred any material costs as a result of such indemnification obligations. The Company is not currently aware of any indemnification claims and has not accrued any liabilities related to such obligations in its consolidated financial statements as of March 31, 2019 or December 31, 2018.

License Agreements

Arsanis entered into an agreement (the "Adimab Option Agreement") in February 2017, which was acquired by the Company as a result of the Merger, under which the Company is obligated to make contingent and non-contingent payments should the Company exercise its option to obtain rights to certain RSV antibodies. If the Company chose to exercise its option, it would be obligated to pay Adimab an option fee of approximately $250 and make clinical and regulatory milestone payments of up to approximately $25,000, as well as royalty payments on a product-by-product and country-by-country basis of a mid single-digit percentage based on net sales by the Company, its affiliates, licensees or sublicensees of products based on certain RSV antibodies during the applicable term for such product in that country. The Company may choose to exercise its option under the terms of the Adimab Option Agreement at any time on or before August 31, 2019. As of March 31, 2019, the Company had not exercised its option under the Adimab Option Agreement.

Legal Proceedings

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

10. Preferred and Common Stock Warrants

As of March 31, 2019, the Company's outstanding warrants to purchase shares of common stock consisted of the following:

Issuance Date	Number of Shares of Common Stock Issuable	Exercise Price	Classification	Expiration Date
August 14, 2015	81,228	$ 21.78	Equity	August 14, 2020
August 21, 2015	69,603	$ 21.78	Equity	August 21, 2020
October 25, 2016	5,155	$ 19.78	Equity	October 24, 2026
November 1, 2017	130,609	$ 19.78	Equity	October 31, 2020
November 17, 2017	8,442	$ 19.78	Equity	November 16, 2020
December 4, 2017	5,661	$ 19.78	Equity	December 3, 2020
December 28, 2017	6,925	$ 19.78	Equity	December 27, 2020
December 28, 2017	115,916	$ 19.78	Equity	December 28, 2027
September 12, 2018	25,275	$ 19.78	Equity	September 12, 2021
September 12, 2018	20,220	$ 19.78	Equity	September 12, 2028
October 19, 2018	20,016	$ 19.78	Equity	October 19, 2028
December 11, 2018	5,004	$ 19.80	Equity	October 19, 2028
	494,054			

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As of December 31, 2018, the Company's outstanding warrants to purchase shares of preferred stock (which converted into warrants to purchase common stock upon close of the Merger) consisted of the following (not adjusted for the Reverse Stock Split or Exchange Ratio):

		December 31, 2018				
Warrant Name	Issuance Date	Number of Shares of Preferred Stock Issuable	Exercise Price	Exercisable for	Classification	Expiration Date
Series A warrants	August 14, 2015	854,785	$ 2.07	Series A	Liability	August 14, 2020
Series A warrants	August 21, 2015	732,453	$ 2.07	Series A	Liability	August 21, 2020
SVB warrants	October 25, 2016	54,256	$ 1.88	Series A	Liability	October 24, 2026
Series B warrants	November 1, 2017	1,374,435	$ 1.88	Series B	Liability	October 31, 2020
Series B warrants	November 17, 2017	88,845	$ 1.88	Series B	Liability	November 16, 2020
Series B warrants	December 4, 2017	59,576	$ 1.88	Series B	Liability	December 3, 2020
Series B warrants	December 28, 2017	72,875	$ 1.88	Series B	Liability	December 27, 2020
Series B warrants	December 28, 2017	1,219,815	$ 1.88	Series B	Liability	December 28, 2027
Series B warrants	September 12, 2018	265,957	$ 1.88	Series B	Liability	September 12, 2021
Series B warrants	September 12, 2018	212,765	$ 1.88	Series B	Liability	September 12, 2028
Series B warrants	October 19, 2018	210,638	$ 1.88	Series B	Liability	October 19, 2028
		5,146,400				

Prior to the Merger, the Company classified its preferred stock warrants as a liability on its consolidated balance sheet because the warrants are freestanding financial instruments that may have required the Company to transfer assets upon exercise. The liability associated with each of these warrants was initially recorded at fair value upon the issuance date of each warrant and is subsequently remeasured to fair value as a component of other income (expense), net in the consolidated statement of operations and comprehensive loss. Upon the closing of the Merger with Arsanis (see Note 1), pursuant to the Merger Agreement, all of the outstanding X4 preferred stock was converted to Arsanis common stock and the X4 preferred stock warrants converted to warrants for the purchase of Arsanis common stock. The Company assessed the features of the warrants and determined that they qualify for classification as permanent equity upon the closing of the Merger. Accordingly, the Company remeasured the warrants to fair value upon the closing of the Merger, which was $5,235 at March 13, 2019, with $288 of expense recorded during the three months ended March 31, 2019. Upon the closing of the Merger, the warrant liability was reclassified to additional paid-in capital.

11. Common Stock, Redeemable Common Stock, and Convertible Preferred Stock (converted to Common Stock)

Common Stock

As of March 31, 2019 and December 31, 2018, the Company's certificate of incorporation, as amended and restated, authorized the Company to issue 33,333,333 shares and 11,070,776, shares, respectively, of $0.001 par value common stock. The voting, dividend and liquidation rights of the holders of the Company's common stock are subject to and qualified by the rights, powers and preferences of the holders of the preferred stock.

Each share of common stock entitles the holder to one vote on all matters submitted to a vote of the Company's stockholders. Common stockholders are entitled to receive dividends, as may be declared by the board of directors, if any. Through March 31, 2019 and December 31, 2018, no cash dividends had been declared or paid.

Redeemable Common Stock

Pursuant to the requirements of the July 2014 license agreement with Genzyme (see Note 13), in August 2015, the Company issued to Genzyme for no additional consideration 107,371, as adjusted for the Reverse Stock Split and Exchange Ratio, shares of common stock, which had an aggregate fair value of $734 on the date of issuance. Genzyme had the right to require the Company to repurchase all, but not less than all, of these shares of common stock at any time during the term of the license agreement for a price of $0.01 per share. Because of this redemption feature, the shares of common stock issued to Genzyme were classified outside of stockholders' deficit on the consolidated balance sheets. As a result of the Merger, these shares were exchanged for common stock.

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Convertible Preferred Stock (converted to Common Stock)

The Company has issued Series Seed convertible preferred stock (the "Series Seed preferred stock"), Series A convertible preferred stock (the "Series A preferred stock") and Series B convertible preferred stock (the "Series B preferred stock"). As of March 31, 2019 and December 31, 2018, the Company's certificate of incorporation, as amended and restated, authorized the Company to issue a total of 10,000,000 shares and 59,413,523 shares, respectively, of preferred stock, with a par value of $0.001 per share.

The holders of Preferred Stock have liquidation rights in the event of a deemed liquidation that, in certain situations, are not solely within the control of the Company. Therefore, the Preferred Stock is classified outside of stockholders' deficit on the consolidated balance sheet.

As of March 31, 2019, there were no preferred stock outstanding. As of December 31, 2018, the Preferred Stock consisted of the following:

	December 31, 2018				
	Preferred Stock Designated	Preferred Stock Issued and Outstanding	Carrying Value	Liquidation Preference	Common Stock Issuable Upon Conversion(1)
Series Seed preferred stock	2,313,523	1,516,136	$ 1,310	$ 1,444	143,630
Series A preferred stock	22,000,000	19,946,862	32,480	47,624	1,895,610
Series B preferred stock	25,100,000	18,616,569	30,885	34,999	1,769,190
	49,413,523	40,079,567	$64,675	$ 84,067	3,808,430

(1) Adjusted to reflect Reverse Stock Split and Exchange Ratio.

12. Stock-Based Compensation

Summary of Plans

Upon completion of the Merger with Arsanis on March 13, 2019, X4's 2015 Employee, Director and Consultant Equity Incentive Plan, as amended (the "2015 Plan"), Arsanis' 2017 Equity Incentive Plan (the "2017 Plan") and Arsanis' 2017 Employee Stock Purchase Plan (the "2017 ESPP") (collectively, the "Plans") were assumed by the Company. These Plans are administered by the board of directors or, at the discretion of the board of directors, by a committee of the board of directors. The exercise prices, vesting and other restrictions are determined at the discretion of the board of directors, or its committee if so delegated, except that the exercise price per share of stock options may not be less than 100% of the fair market value of the share of common stock on the date of grant and the term of the stock option may not be greater than ten years. Incentive stock options granted to employees and restricted stock awards granted to employees, officers, members of the board of directors, advisors, and consultants of the Company typically vest over four years. Non-statutory options granted to employees, officers, members of the board of directors, advisors, and consultants of the Company typically vest over three or four years. Shares that are expired, terminated, surrendered or canceled under the Plans without having been fully exercised will be available for future awards. In addition, shares of common stock that are tendered to the Company by a participant to exercise an award are added to the number of shares of common stock available for the grant of awards.

2015 Employee, Director and Consultant Equity Incentive Plan

In 2015, the board of directors and shareholders of X4 adopted the 2015 Plan, which provided for the Company to grant incentive stock options or nonqualified stock options, restricted stock awards and other stock-based awards to employees, directors and consultants of the Company. Each stock option outstanding under the 2015 Plan at the effective time of the Merger was automatically converted into a stock option exercisable for a number of shares of the Company's common stock calculated based on the Exchange Ratio and the exercise price per share of such outstanding stock option.

The total number of shares of common stock that may be issued under the 2015 Plan was 1,700,000 shares, adjusted for the reverse stock split as of December 31, 2018 and March 31, 2019. Shares that are expired, forfeited, canceled or otherwise terminated without having been fully exercised will be available for future grant under the 2015 Plan. In addition, shares of common stock that are tendered to the Company by a participant to exercise an award are added to the number of shares of common stock available for future grants.

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2017 Equity Incentive Plan

In 2017, the board of directors and shareholders of Arsanis adopted the 2017 Plan which provided for the Company to grant incentive stock options, non-qualified options, stock appreciation rights, restricted stock awards, restricted stock units and other stock-based awards. Incentive stock options may be granted only to the Company's employees, including officers and directors who are also employees. Awards other than incentive stock options may be granted to employees, officers, members of the board of directors, advisors and consultants of the Company. The number of shares of common stock reserved for issuance under this plan will automatically increase on January 1 of each year, through January 1, 2027, in an amount equal to the lowest of 1,025,490 shares of the Company's common stock, 4% of the number of shares of the Company's common stock outstanding on January 1 of each year and an amount determined by the Company's board of directors.

2017 Employee Stock Purchase Plan

In 2017, the board of directors and shareholders of Arsanis adopted the 2017 ESPP. The 2017 ESPP provides participating employees with the opportunity to purchase shares of the Company's common stock at defined purchase prices over six-month offering periods. For the three month period ended March 31, 2019, no shares of common stock were issued under the 2017 ESPP.

Stock Option Valuation

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

The following table presents, on a weighted average basis, the assumptions used in the Black-Scholes option-pricing model to determine the grant-date fair value of stock options granted to employees, directors and non- employees:

	Three Months Ended March 31,	
	2019	2018
Risk-free interest rate	2.4%	2.8%
Expected term (in years)	5.90	5.94
Expected volatility	90.6%	86.0%
Expected dividend yield	0%	0%

Stock Options

The following table summarizes the Company's stock option activity since December 31, 2018:

	Number of Shares	Weighted Average Exercise Price	Weighted Average Contractual Term (Years)	Aggregate Intrinsic Value
Outstanding as of December 31, 2018	797,931	$ 8.29	8.42	$ 6,486
Assumed as part of Merger with Arsanis	271,230	62.60		
Granted	136,913	17.22		
Exercised	(16,483)	6.85		
Forfeited	(22,378)	8.43		
Outstanding as of March 31, 2019	1,167,213	$ 21.97	7.65	$ 7,168
Exercisable as of March 31, 2019	556,774	$ 30.13		
Vested and expected to vest as of March 31, 2019	979,466	$ 48.79		

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The aggregate intrinsic value of options is calculated as the difference between the exercise price of the stock options and the fair value of the Company's common stock for those options that had exercise prices lower than the fair value of the Company's common stock. The aggregate intrinsic value of stock options exercised during the three months ended March 31, 2019 was $123. The weighted average grant-date fair value per share of stock options granted during the three months ended March 31, 2019 was $12.88.

Stock-Based Compensation

Effective January 1, 2019, the Company adopted ASU 2018-07 which required the Company to adjust compensation expense for the three months ended March 31, 2019 for an immaterial amount for the unvested non-employee share options outstanding. The Company no longer remeasures the fair value of options granted to non-employees at each reporting period end (see Note 2).

During the three months ended March 31, 2019, the Company granted options to purchase 136,913 shares of common stock. As of March 31, 2019, total unrecognized compensation expense related to unvested stock options award was $5,066, which is expected to be recognized over a weighted average period of 2.5 years.

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

	Three Months Ended March 31,	
	2019	2018
Research and development expense	$ 84	$ 38
General and administrative expense	178	90
Total stock-based compensation	262	128

13. License, Collaboration, and Funding Agreements

Genzyme Agreement

In July 2014, the Company entered into a license agreement (the "Genzyme Agreement") with Genzyme pursuant to which the Company was granted an exclusive license to certain patents and intellectual property owned or controlled by Genzyme related to the CXCR4 receptor to develop and commercialize products containing licensed compounds (including but not limited to X4P-001) for all therapeutic, prophylactic and diagnostic uses, with the exception of autologous and allogenic human stem cell therapy. Under the terms of the Genzyme Agreement, the Company is obligated to use commercially reasonable efforts to develop and commercialize licensed products for use in the field in the United States and at least one other major market country. The Company has the right to grant sublicenses of the licensed rights that cover X4P-001 to third parties.

In exchange for these rights, in August 2014, the Company made an upfront payment of $50 to Genzyme. The Company accounted for the acquisition of technology as an asset acquisition because it did not meet the definition of a business. The Company recorded the upfront payment as research and development expense in the consolidated statement of operations and comprehensive loss because the acquired technology represented in-process research and development and had no alternative future use. In August 2015, as a result of the closing of the Company's Series A preferred stock financing, the Company made an additional cash payment of $300 to Genzyme and issued to Genzyme 107,371 shares of its common stock, as adjusted for the 6 for 1 Reverse Stock Split and Exchange Ratio (see Note 11), each as required by the Genzyme Agreement. The $300 payment and the $734 fair value of the 107,371 shares of common stock issued to Genzyme were recorded as research and development expense in the consolidated statements of operations and comprehensive loss for the year ended December 31, 2015. Prior to the Merger with Arsanis, Genzyme has the right to require the Company to repurchase all, but not less than all, of these shares of common stock at any time during the term of the Genzyme Agreement for a price of $0.01 per share. Due to this redemption feature, the shares of common stock issued to Genzyme were classified outside of stockholders' deficit on the consolidated balance sheets as of December 31, 2018. On March 13, 2019, the closing date of the Merger with Arsanis, these redeemable common shares were exchanged for common shares and, as a result, the fair value of the shares was reclassified to permanent equity.

Under the Genzyme Agreement, the Company is obligated to pay Genzyme milestone payments in the aggregate amount of up to $25,000, contingent upon the achievement by the Company of certain late-stage regulatory and sales milestones with respect to

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licensed products. In addition, the Company may be required to make a one-time milestone payment to Genzyme upon the consummation by the Company of a change of control transaction, in an amount equal to 5.5% of the consideration paid to equity holders of the Company, other than Genzyme, in connection with such change of control transaction, after deducting outstanding debt obligations of the Company and the aggregate cash investments made by equity holders into the Company prior to the closing of the change of control transaction. The Merger with Arsanis qualifies as a change of control transaction, as defined in the license agreement, but results in no payment being due to Genzyme under the license agreement.

The Company concluded that this contingent payment obligation meets the definition of a derivative instrument as the contingent payment obligation is not clearly and closely related to its host instrument and is a cash-settled liability (see Note 2). Accordingly, the Company classifies this derivative as a liability within other liabilities (non-current) on its consolidated balance sheet (see Note 2), and changes in the fair value of the derivative liability are recognized as a component of other income (expense), net in the consolidated statement of operations and comprehensive loss (see Note 4). On March 13, 2019, the closing date of the Merger with Arsanis, this derivative liability was remeasured to fair value, which was $0, and subsequent changes in fair value will no longer be recognized in the consolidated statements of operations and comprehensive loss because the contingent payment obligation expired at that time.

Under the Genzyme Agreement, the Company is obligated to pay Genzyme tiered royalties based on net sales of licensed products that the Company commercializes under the agreement. The obligation to pay royalties for each licensed product expires on a country-by-country basis on the latest of (i) the expiration of licensed patent rights that cover that licensed product in that country, (ii) the expiration of regulatory exclusivity in that country and (iii) ten years after the first commercial sale of such licensed product in that country. Royalty rates are subject to reduction under the agreement in specified circumstances, including in any country if the Company is required to obtain a license from any third party to the extent the Company's patent rights might infringe the third party's patent rights, if a licensed product is not covered by a valid claim in that country or if sales of generic products reach certain thresholds in that country. If the Company enters into a sublicense under the agreement, the Company will be obligated to pay Genzyme a percentage of certain upfront fees, maintenance fees, milestone payments and royalty payments paid to the Company by the sublicensee.

Under the Genzyme Agreement, the Company will itself manufacture and supply, or enter into manufacturing or supply agreements with Genzyme or third parties to manufacture and supply, clinical and commercial supplies of licensed compounds and each licensed product. During the three months ended March 31, 2019 and 2018, the Company did not enter into any third-party manufacturing or supply agreements in connection with the Genzyme Agreement. The Company is also responsible for all costs related to the filing, prosecution and maintenance of the licensed patent rights.

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

During the three months ended March 31, 2019 and 2018, the Company did not incur any payment obligations to Genzyme under the Genzyme Agreement.

Georgetown Agreement

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

Under the terms of the Georgetown Agreement, the Company paid a one-time only, upfront fee of $50 and the Company may be required to pay milestone payments of up to an aggregate of $800 related to commercial sales of a product. The Company accounted for the acquisition of technology as an asset acquisition because it did not meet the definition of a business. The Company recorded the upfront payment as research and development expense in the consolidated statement of operations and comprehensive loss because the acquired technology represented in-process research and development and had no alternative future use.

Under the Georgetown Agreement, the Company is solely responsible for all development and commercialization activities and costs in its respective territories. The Company is also responsible for all costs related to the filing, prosecution and maintenance of the licensed patent rights.

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The term of the Georgetown Agreement will continue until the expiration of the last valid claim within the patent rights covering the product. Georgetown may terminate the agreement in the event (i) the Company fails to pay any amount and fails to cure such failure within 30 days after receipt of notice, (ii) the Company defaults in its obligation to obtain and maintain insurance and fails to remedy such breach within 45 days after receipt of notice, or (iii) the Company declares insolvency or bankruptcy. The Company may terminate the agreement at any time upon at least 60 days' written notice.

During the three months ended March 31, 2019 and 2018, the Company did not incur any payment obligations to Georgetown under the Georgetown Agreement and no milestone payments were made or due under the Georgetown Agreement.

Beth Israel Deaconess Medical Center Agreement

In December 2016, the Company entered into a license agreement (the "BIDMC Agreement") with Beth Israel Deaconess Medical Center ("BIDMC"), pursuant to which the Company obtained an exclusive, worldwide license to make, have made, use, sell, offer for sale and import of products covered by patent rights co-owned by BIDMC. The rights licensed to the Company are for all fields of use.

Under the terms of the BIDMC Agreement, the Company paid a one-time only, upfront fee of $20 and the Company is responsible for all future patent prosecution costs. The Company accounted for the acquisition of technology as an asset acquisition because it did not meet the definition of a business. The Company recorded the upfront payment as research and development expense in the consolidated statement of operations and comprehensive loss because the acquired technology represented in-process research and development and had no alternative future use.

The term of the BIDMC Agreement will continue until the expiration of the last valid claim within the patent rights covering the licensed products. BIDMC may terminate the agreement in the event (i) the Company fails to pay any amount and fails to cure such failure within 15 days after receipt of notice, (ii) the Company is in material breach of any material provision of the agreement and fails to remedy such breach within 60 days after receipt of notice, or (iii) the Company declares insolvency or bankruptcy. We may terminate the agreement at any time upon at least 90 days' written notice.

The Company did not incur any payment obligations under the BIDMC Agreement during the months ended March 31, 2019 and 2018.

Adimab Option and License Agreement

In February 2017, Arsanis entered into an option and license agreement with Adimab, a related party (the "Adimab Option Agreement"). Under the Adimab Option Agreement, Adimab has provided to Arsanis certain proprietary antibodies against respiratory syncytial virus ("RSV antibodies") for its evaluation during a specified option period and has granted Arsanis an exclusive, non-sublicensable license in a specified field under certain Adimab patent rights and know-how during the option period. Under the Adimab Option Agreement, the Company has an exclusive option, exercisable during the option period upon payment of an option fee to Adimab, to require Adimab to assign to the Company all rights in up to a specified number of RSV antibodies selected by the Company and certain patent rights owned by Adimab that cover these antibodies, and to obtain from Adimab a non-exclusive license in a specified field, with the right to grant sublicenses, under certain other patent rights and know-how owned by Adimab.

If the Company exercises its option under the Adimab Option Agreement, the Company is required to use commercially reasonable efforts to develop and commercialize at least one product based on a licensed RSV antibody in major markets and is obligated to pay Adimab an option fee of $0.3 million and make future milestone payments upon the achievement of specified clinical and regulatory milestones in the aggregate amount of up to $24.4 million. The Company is obligated to pay Adimab royalties at a mid single-digit percentage of net sales of products based on the initial RSV antibodies (including modified or derivative forms of those antibodies created by or for the Company) by the Company or any of its affiliates, licensees or sublicensees, regardless of whether these products practice any of the assigned or licensed patents or know-how. If the Company materially breaches these diligence obligations, Adimab will have the right to terminate the Adimab Option Agreement.

The Company has no payment obligations under the Adimab Option Agreement with respect to sales of products based on licensed RSV antibodies to the extent they are sold at cost in developing countries under the February 2017 Gates Foundation grant agreement, as amended and restated in August 2018, and the August 2018 Gates Foundation grant agreement (which are described in further detail below). However, if such products are sold in developing countries for an amount that exceeds cost, then the amount of such excess will be subject to the royalty payment obligations described in the preceding paragraph.

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If the Company does not exercise its option, the Adimab Option Agreement will expire on the Company's achievement of specified preclinical milestones under the grant agreements with the Gates Foundation, but in any event no later than mid-2019. If the Company does exercise its option, the Adimab Option Agreement will expire on the last-to-expire royalty term (defined, on a product-by-product and country-by-country basis, as the period ending on the later of twelve years after the first commercial sale of such product in such country and the expiration of the last of a specified set of patents and patent applications covering such product in such country) for any and all products for which the Company is obligated to pay Adimab royalties under the Adimab Option Agreement. The Company has the right to terminate the Adimab Option Agreement for any reason by providing Adimab with a specified amount of prior written notice. Adimab has the right to terminate the Adimab Option Agreement if the Company materially breaches the agreement and fails to cure such breach within a specified cure period, including for the Company's failure to use commercially reasonable efforts to develop and commercialize at least one product based on a licensed RSV antibody in major markets. If Adimab terminates the Adimab Option Agreement for the Company's breach, if the Company terminates the agreement for convenience or if the agreement expires before the Company exercises its option, then the Company must return or destroy certain know-how, including all initial RSV antibodies, and all modified or derivative forms of those antibodies, in its possession other than those for which the Company has made all payments required under the Adimab Option Agreement, assign certain patents covering certain RSV antibodies to Adimab, grant Adimab a non-exclusive, royalty-free license under certain other patents, and grant Adimab a time-limited right of first negotiation to obtain an exclusive license to certain patents and know-how and the transfer and assignment of certain regulatory filings and approvals and other related assets related to products based on licensed RSV antibodies. Certain of the Company's payment obligations relating to specified products and patents arising from the agreement survive expiration or termination of the agreement.

During the three months ended March 31, 2019, the Company recognized no research and development expense in connection with the Adimab Option Agreement.

Adimab Collaboration Agreement

In May 2011, Arsanis entered into a collaboration agreement with Adimab, LLC ("Adimab") and together with certain applicable option exercise letters the Company has sent to Adimab, the "Adimab Collaboration Agreement"). Under the Adimab Collaboration Agreement, the Company and Adimab were required to use reasonable efforts to conduct certain research, which was funded by the Company, to discover and optimize antibodies directed against targets selected by the Company. With respect to each target that was the subject of the research, the Company had an exclusive option to obtain, with respect to a specified number of antibodies directed against such target and discovered or optimized by Adimab, (i) ownership of certain patent rights relating to such antibodies and (ii) exclusive and non-exclusive licenses in a specified field, with the right to grant sublicenses, under certain patent rights and know-how.

Under the Adimab Collaboration Agreement, for each target for which the Company has exercised an option, the Company is required to use commercially reasonable efforts to develop and commercialize at least one product in major markets. If the Company does not fulfill these diligence obligations, Adimab may consider it a material breach, allowing Adimab to terminate the Adimab Collaboration Agreement with respect to such target and all associated products.

The Company is obligated to pay Adimab royalties at a mid single-digit percentage of net sales made by the Company or its affiliates of products based on antibodies for which the Company exercised its option, or products that use or are based on any antibody discovered or optimized under the agreement, any derivative or modified version of any such antibody, or any sequence information as to any such antibody. In addition, if the Company sells or licenses to any third party, or otherwise grants rights to any third party to, any of the products for which the Company is obligated to pay Adimab royalties, either alone or as part of a package including specified patents not directed to these antibodies, the Company is obligated to pay Adimab either (i) the same royalties on net sales of such products by such third party or (ii) a percentage, ranging from the low double digits to a maximum of less than 30%, of the payments the Company receives from such third parties that are attributable to such grant of rights. In April 2017, the Company entered into a letter agreement with the Gates Foundation, pursuant to which the Company licensed to the Gates Foundation certain rights under its ASN100 program. The Company has no payment obligations under the Adimab Collaboration Agreement with respect to sales of certain antibody products if they are sold at cost in developing countries under its letter agreement with the Gates Foundation. However, if such products are sold in developing countries for an amount that exceeds cost, then the amount of such excess over cost will be subject to the royalty payment obligations described above.

If the Company (or one of its affiliates with rights under the agreement) undergoes a change in control and, at the time of such change in control, the Company has not sold or licensed to third parties all of its rights in antibodies for which the Company is obligated to pay Adimab royalties under the agreement, then the Company is obligated to either (i) pay Adimab a percentage, in the mid double digits, of the payments it receives from that change in control that are reasonably attributable to those rights and certain patents arising

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from the collaboration or (ii) require the Company's acquirer and all of its future third-party collaborators to pay to Adimab the royalties at a mid single-digit percentage of net sales based on those rights. If the Company grants rights to a third party under certain patents that are not directed to the antibodies for which the Company is obligated to pay Adimab royalties (as described above), the Company is also obligated to pay Adimab, in place of royalties or a percentage of payments received from the third party, a lump sum in the high six digits.

The Adimab Collaboration Agreement will expire on a country-by-country basis twelve years after the first commercial sale in such country of the last product for which the Company is obligated to pay Adimab royalties in such country under the Adimab Collaboration Agreement. The Company has the right to terminate the Adimab Collaboration Agreement for any reason by providing Adimab with a specified amount of prior written notice. Adimab has the right to terminate the Adimab Collaboration Agreement if the Company materially breaches the agreement and fails to cure such breach within a specified cure period, including for its failure to use commercially reasonable efforts to develop and commercialize at least one product directed at a target for which the Company has exercised an option in major markets. If Adimab terminates the Adimab Collaboration Agreement for the Company's breach, or if the Company terminates the agreement for convenience, then the Company must transfer or license to Adimab certain rights and assets relating to targets and antibodies for which the Company has exercised its option. Adimab is then obligated to make payments to the Company with respect to these targets and antibodies that are similar to the payments the Company is required to make to Adimab during the term of the agreement. Certain of the Company's payment obligations relating to specified products and patents arising from the agreement survive expiration or termination of the agreement.

During the three months ended March 31, 2019, the Company did not recognize any research and development under the Adimab Collaboration Agreement.

Gates Foundation Grant Agreements

In February 2017, Arsanis entered into a grant agreement with the Gates Foundation ("Grant Agreement"), under which the Gates Foundation agreed to provide the Company up to approximately $9,300 to conduct preclinical development of monoclonal antibodies for the prevention of RSV infection in newborns (the "RSV project").

In connection with this Grant Agreement, the Company has granted to the Gates Foundation a non-exclusive, perpetual, royalty-free, fully paid up, sublicensable license to make, use, sell, offer to sell, import, distribute, copy, modify, create derivative works, publicly perform and display the funded developments and, to the extent incorporated into a funded development or required to use a funded development, any other technology created outside of the RSV project that was used as part of the RSV project, for the benefit of people in developing countries. This license survives any expiration or termination of the grant agreement. The Grant Agreement expires on October 31, 2019. The Gates Foundation can modify, suspend or discontinue any payment under the grant agreement, or terminate the grant agreement, if it is not reasonably satisfied with the Company's progress on the RSV project; if there are significant changes to the Company's leadership or other factors that the Gates Foundation reasonably believes may threaten the RSV project's success; if the Company undergoes a change in control; if there is a change in the Company's tax status; if the RSV project is no longer aligned with the Gates Foundation's programmatic strategy; or if the Company fails to comply with the grant agreement. Any grant funds that have not been used for, or committed to, the RSV project upon the expiration or termination of the grant agreement must be returned to the Gates Foundation or otherwise used as directed by the Gates Foundation. In August 2018, Arsanis entered into an amended and restated grant agreement which replaced the February 2017 grant agreement in its entirety. The amended and restated grant agreement includes amendments to conform to current Gates Foundation audit, reporting, and other administrative requirements, as well as to make the perpetual Gates Foundation license grant described below irrevocable.

During the three months ended March 31, 2019, the Company did not incur qualifying expenses under the letter agreement with the Gates Foundation.

Research and Development Incentive Program

The Company participates in a research and development incentive program provided by the Austrian government whereby the Company is entitled to reimbursement by the Austrian government for a percentage of qualifying research and development expenses incurred by the Company's subsidiary in Austria. Under the program, the reimbursement rate for qualifying research and development expenses incurred by the Company through its subsidiary in Austria is 14% for the current year .

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

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(Unaudited)

As of March 31, 2019, the Company recorded receivables for amounts due under the program of $1.6 million, which amounts were included in grant and incentive receivables in the consolidated balance sheet.

Janssen License and Option Agreement

On December 12, 2018, Arsanis entered into a patent license and option agreement with Janssen Pharmaceuticals, Inc. ("Janssen"), (the "Janssen License and Option Agreement"). Pursuant to the Janssen License and Option Agreement, Arsanis granted to Janssen (i) a non-exclusive license to specified patents in Arsanis's portfolio related to the ASN200 E. coli program, and (ii) an option for Janssen to acquire these patents in the future if specified conditions are met. Janssen agreed to pay Arsanis $3.5 million within 15 business days after the December 12, 2018 effective date of the Janssen License and Option Agreement, in addition to a future $0.5 million payment in the event Janssen exercises its option to acquire the relevant patents. Arsanis received the $3.5 million payment from Janssen in December 2018 and recognized this amount as revenue. Such revenue is not reflected in the consolidated financial statements of the Company as it occurred prior to the Merger. Janssen's option to the relevant patents will be recognized as revenue in full in the period in which the option exercise occurs.

14. Income Taxes

The Company did not record a federal or state income tax benefit for its losses for the three months ended March 31, 2019 and 2018 due to the conclusion that a full valuation allowance is required against the Company's deferred tax assets.

15. Net Loss per Share

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

	Three Months Ended March 31,	
	2019	2018
Numerator:		
Net loss	$ (10,873)	$ (7,367)
Accruing dividends on Series A convertible preferred stock	(592)	(740)
Net loss attributable to common stockholders	$ (11,465)	$ (8,107)
Denominator:		
Weighted average common shares outstanding—basic and diluted	1,717,808	457,971
Net loss per share attributable to common stockholders—basic and diluted	$ (6.67)	$ (17.70)

The Company has included 107,371 shares of redeemable common stock in its computation of basic and diluted weighted average common shares outstanding for the three months ended March 31, 2019 and 2018 as this class of stock participates in losses similarly to other common stockholders.

The Company's potentially dilutive securities included outstanding stock options, convertible preferred stock, and warrants to purchase shares of convertible preferred stock for the three month period ended March 31, 2018 and included outstanding stock options and warrants to purchase common stock for the three month period ended March 31, 2019. These potentially dilutive securities have been excluded from the computation of diluted net loss per share as the effect would be to reduce the net loss per share, and thus they are considered "anti-dilutive." Therefore, the weighted average number of common shares outstanding used to calculate both basic and diluted net loss per share attributable to common stockholders is the same. The Company excluded the following potential common shares, presented based on amounts outstanding at each period end and adjusted for the Exchange Ratio and Reverse Stock Split, from the computation of diluted net loss per share attributable to common stockholders for the periods indicated because including them would have had an anti-dilutive effect:

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(Unaudited)

	Three Months Ended March 31,	
	2019	2018
Options to purchase common stock	1,037,089	538,429
Convertible preferred stock (as converted to common stock)	—	3,556,147
Warrants to purchase common stock (presented on an as-converted, as exchanged, split-adjusted basis.	493,927	423,416
	1,531,016	4,517,992

16. Subsequent Events

On April 12, 2019, the Company entered into an underwriting agreement with Cowen and Company, LLC and Stifel, Nicolaus & Company, Incorporated, as representatives of the several underwriters named therein pursuant to which it sold 5,670,000 shares of common stock and, in lieu of common stock, pre-funded warrants to purchase 2,130,000 shares of common stock, and accompanying Class A warrants to purchase 3,900,000 shares of its common stock, at a price to the public of $11.00 per share and accompanying Class A warrants (or $10.999 per pre-funded warrant and accompanying Class A warrants). The Class A warrants have an exercise price of $13.20, will expire five years from the date of issuance, and are immediately exercisable with certain restrictions. The gross proceeds from the offering were $85.8 million before deducting underwriting discounts and estimated offering expenses. The offering closed on April 16, 2019.

X4 PHARMACEUTICALS, INC.

Item 2. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

You should read the following discussion and analysis of our financial condition and results of operations together with our consolidated financial statements and the related notes included elsewhere in this Quarterly Report on Form 10-Q. Some of the information contained in this discussion and analysis or set forth elsewhere in this Quarterly Report on Form 10-Q, including information with respect to our plans and strategy for our business and related financing, includes forward-looking statements that involve risks, uncertainties and assumptions. Our actual results, performance or experience could differ materially from what is indicated by any forward-looking statement due to various important factors, risks and uncertainties, including, but not limited to, those set forth under "Cautionary Note Regarding Forward-Looking Statements" included elsewhere in this Quarterly Report on Form 10-Q or under "Risk Factors" in Item 1A of Part I of our Annual Report on Form 10-K for the fiscal year ended December 31, 2018, as updated by our Current Report on Form 8-K filed on April 11, 2019 and our subsequent filings under the Exchange Act.

Overview

We are a clinical-stage biopharmaceutical company focused on the discovery, development and commercialization of novel therapeutics for the treatment of rare diseases. Our pipeline is comprised of potentially first-in-class, oral, small molecule antagonists of chemokine receptor CXCR4, which have the potential to treat a broad range of rare diseases, including primary immunodeficiencies, or PIs, and certain types of cancer. CXCR4 is stimulated by its only chemokine ligand, CXCL12, and plays a key role in enabling the trafficking of immune cells and effectively monitoring the function of the immune system, or immunosurveillance. Overstimulation of the CXCL12/CXCR4 pathway leads to inhibition of the immune response, or immunosuppression. Our lead product candidate, mavorixafor (X4P-001), has completed a Phase 2 clinical trial in patients with Warts, Hypogammaglobulinemia, Infections, and Myelokathexis, or WHIM, syndrome, which is a PI. We plan to initiate a Phase 3 pivotal clinical trial of mavorixafor for the treatment of patients with WHIM syndrome in the second quarter of 2019 and report top-line data from this trial in 2021. Beyond WHIM syndrome, we plan to initiate a Phase 1 clinical trial of mavorixafor in another PI, severe congenital neutropenia, or SCN, and a Phase 1/2 clinical trial of mavorixafor in Waldenström macroglobulinemia, or WM, in 2019. We expect to report data from the SCN trial in the middle of 2020 and data from the WM trial in the second half of 2020. We were founded and are led by a team with extensive product development and commercialization expertise, including several former members of the Genzyme leadership team, and we are located in Cambridge, Massachusetts.

Recent Developments

Reverse Merger

On March 13, 2019, X4 Pharmaceuticals, Inc., formerly Arsanis, Inc. (the "Company"), completed a business combination with X4 Therapeutics, Inc., formerly X4 Pharmaceuticals, Inc. ("X4"), in accordance with the terms of the Agreement and Plan of Merger, dated as of November 26, 2018, as amended on December 20, 2018 and March 8, 2019 (the "Merger Agreement"), by and among the Company, X4 and Artemis AC Corp., a Delaware corporation and a wholly owned subsidiary of the Company ("Merger Sub"), pursuant to which, among other matters, Merger Sub merged with and into X4 with X4 continuing as a wholly owned subsidiary of the Company and the surviving corporation of the merger (the "Merger"). Following the completion of the Merger on March 13, 2019, the the Company effected a 1-for-6 reverse stock split of its common stock (the "Reverse Stock Split") and changed its name to "X4 Pharmaceuticals, Inc." Following the completion of the Merger, the business conducted by the combined organization became primarily the business conducted by X4. Unless noted otherwise, all references to common stock share and per share amounts reflect the Reverse Stock Split. As used herein, the words "the Company," "we," "us," and "our" refer to, for periods following the Merger, X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc.), together with is direct and indirect subsidiaries, and for periods prior to the Merger, X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.), and its direct and indirect subsidiaries, as applicable. In addition, the word "Arsanis" refers to the Company prior to the completion of the Merger.

Under the terms of the Merger Agreement, at the closing of the Merger, the Company issued an aggregate of approximately 25.7 million shares of its common stock to X4 stockholders, based on a common stock exchange ratio of 0.5702 shares of the Company's common stock for each share of X4's common stock outstanding immediately prior to the Merger and a preferred stock exchange ratio of 0.5702 shares of the Company's common stock for each share of X4 preferred stock outstanding prior to the Merger, in each case before taking into account of the Reverse Stock Split (each such exchange ratio, the "Exchange Ratio"). The Company also assumed all of the outstanding and unexercised stock options and warrants to purchase shares of X4 capital stock, with the number of shares subject to such options or warrants representing the right to purchase a number of shares of the Company's common stock equal to 0.5702 multiplied by the number of shares of X4 capital stock previously represented by such options or warrants, before taking into account the Reverse Stock Split. The exercise prices of such options and warrants were also appropriately adjusted to reflect the Exchange Ratio of 0.5702, before taking into account the Reverse Stock Split. As a result of the Reverse Stock Split, the number of shares subject to such options and warrants and the exercise prices of such options and warrants were further adjusted by decreasing the number of shares subject to such options and warrants and increasing the exercise price of such options and warrants on a 1-for-6

Reverse Stock Split basis. The assumed options continue to be governed by the terms of the X4 Therapeutics, Inc. 2015 Employee, Director and Consultant Equity Incentive Plan, as amended, under which the options were originally granted (the "X4 Therapeutics Plan"). Upon the closing of the Merger, X4 Pharmaceuticals, Inc. also assumed the X4 Therapeutics Plan.

Immediately following the Merger and the Reverse Stock Split, there were approximately 6.7 million shares of the X4 Pharmaceuticals, Inc. common stock outstanding, and the former X4 Therapeutics, Inc. stockholders owned approximately 4.3 million shares, or 63.7% of the combined organization's common stock outstanding. In addition, immediately following the Merger and the Reverse Stock Split, the former X4 Pharmaceuticals, Inc. optionholders held options to purchase approximately 0.8 million shares of the combined organization's common stock and the former X4 Pharmaceuticals, Inc. warrantholders held warrants to purchase approximately 0.5 million shares of the combined organization's common stock. Approximately 24.3% of our common stock outstanding immediately after the Merger is held by stockholders subject to lock-up restrictions, pursuant to which such stockholders have agreed, except in limited circumstances, not to sell or transfer, or engage in swap or similar transactions with respect to, shares of the combined organization's common stock, including, as applicable, shares received in the Merger and issuable upon exercise of certain warrants and options, for a period of 180 days following the closing of the Merger.

The business combination has been accounted for as a "reverse merger" in accordance with GAAP. Under this method of accounting, X4 Therapeutics, Inc. is deemed to be the accounting acquirer for financial reporting purposes. This determination was primarily based on the facts that, immediately following the Merger: (i) the stockholders of X4 own a substantial majority of the voting rights in the combined organization, (ii) X4 designated a majority of the members of the initial board of directors of the combined organization and (iii) X4's senior management hold all key positions in the senior management of the combined organization. Accordingly, for accounting purposes, the business combination has been treated as the equivalent of X4 issuing stock to acquire the net assets of Arsanis. As a result, as of the closing date of the Merger, the net assets of Arsanis have been recorded at their acquisition-date fair values in the financial statements of the combined entity and the reported operating results prior to the business combination will be those of X4. Subsequent to the closing of the Merger, the reported operating results will reflect those of the combined organization. In addition, transaction costs incurred by X4 in connection with the business combination have been expensed as incurred.

Our common stock remained listed on the Nasdaq Stock Market, with trading having commenced on a post-Reverse Stock Split basis and under the new name as of March 14, 2019. The trading symbol also changed on that date from "ASNS" to "XFOR."

Equity Financing

On April 16, 2019, we sold 5,670,000 shares of common stock and, in lieu of common stock, pre-funded warrants to purchase 2,130,000 shares of common stock, and accompanying Class A warrants to purchase 3,900,000 shares of our common stock at a price to the public of $11.00 per share and accompanying Class A warrants (or $10.999 per pre-funded warrant and accompanying Class A warrants). The Class A warrants have an exercise price of $13.20, will expire five years from the date of issuance, and are immediately exercisable with certain restrictions. The gross proceeds from the offering were $85.8 million before deducting underwriting discounts and estimated offering expenses.

Operating History

Since our inception in 2012, we have devoted substantially all of our efforts and financial resources to organizing and staffing the company, business planning, raising capital, acquiring or discovering product candidates and securing related intellectual property rights and conducting discovery, research and development activities for our product candidates. We do not have any products approved for sale and have not generated any revenue from product sales. Through December 31, 2018, we have funded our operations primarily with proceeds from sales of preferred stock and proceeds from the issuance of convertible debt and borrowings under loan and security agreements. Through December 31, 2018, we had received net proceeds of $73.7 million from sales of our preferred stock (including proceeds from convertible debt, which converted into preferred stock) and gross proceeds of $16.0 million from borrowings under loan and security agreements, net of amounts used to repay prior loan and security agreements. During the three months ended March 31, 2019 as a result of our Merger with Arsanis, we acquired $25.8 million of cash and short-term marketable securities of Arsanis.

We have incurred significant operating losses since inception. Our ability to generate product revenue sufficient to achieve profitability will depend heavily on the successful development and eventual commercialization of one or more of our current or future product candidates. Our net losses were $10.9 million and $6.2 million for the three months ended March 31, 2019 and 2018, respectively. As of March 31, 2019, we had an accumulated deficit of $90.1 million. We expect to continue to incur significant expenses and increasing operating losses for at least the next several years. We expect that our expenses and capital requirements will increase substantially in connection with our ongoing activities, particularly if and as we:

- conduct additional clinical trials for our product candidates;
- continue to discover and develop additional product candidates;
- acquire or in-license other product candidates and technologies;

- maintain, expand and protect our intellectual property portfolio;
- hire additional clinical, scientific and commercial personnel;
- establish a commercial manufacturing source and secure supply chain capacity sufficient to provide commercial quantities of any product candidates for which we may obtain regulatory approval;
- seek regulatory approvals for any product candidates that successfully complete clinical trials;
- establish a sales, marketing and distribution infrastructure to commercialize any products for which we may obtain regulatory approval; and
- add operational, financial and management information systems and personnel, including personnel to support our product development and planned future commercialization efforts, as well as to support our efforts as a public reporting company.

We will not generate revenue from product sales unless and until we successfully complete clinical development and obtain regulatory approval for our product candidates. If we obtain regulatory approval for any of our product candidates and do not enter into a commercialization partnership, we expect to incur significant expenses related to developing our internal commercialization capability to support product sales, marketing and distribution. Further, we expect to incur additional costs associated with operating as a public company.

As a result, we will need substantial additional funding to support our continuing operations and pursue our growth strategy. Until such time as we can generate significant revenue from product sales, if ever, we expect to finance our operations through the sale of equity, debt financings or other capital sources, which may include collaborations with other companies or other strategic transactions. We may not be able to raise additional funds or enter into such other agreements or arrangements when needed on favorable terms, or at all. If we fail to raise capital or enter into such agreements as and when needed, we may have to significantly delay, reduce or eliminate the development and commercialization of one or more of our product candidates or delay our pursuit of potential in-licenses or acquisitions.

Because of the numerous risks and uncertainties associated with product development, we are unable to predict the timing or amount of increased expenses or when or if we will be able to achieve or maintain profitability. Even if we are able to generate product sales, we may not become profitable. If we fail to become profitable or are unable to sustain profitability on a continuing basis, then we may be unable to continue our operations at planned levels and be forced to reduce or terminate our operations.

We expect that our existing cash and cash equivalents of $22.3 million as of March 31, 2019, together with the $78.9 million of net proceeds from our equity financing in April 2019, will be sufficient to fund our operating expenses, capital expenditure requirements and debt service payments for at least the next 12 months. See " —*Liquidity and Capital Resources*." We will need to raise additional capital to finance our operations, which cannot be assured. See Note 1 of our consolidated financial statements included elsewhere in this Quarterly Report on Form 10-Q for additional information on our assessment.

Components of Results of Operations

Revenue

To date, we have not generated any revenue from product sales and do not expect to generate any revenue from the sale of 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.

Operating Expenses

Research and Development Expenses

Research and development expenses consist primarily of costs incurred in connection with the discovery and development of our product candidates. We expense research and development costs as incurred. These expenses include:

- employee-related expenses, including salaries, related benefits and stock-based compensation expense, for employees engaged in research and development functions;
- expenses incurred in connection with the preclinical and clinical development of our product candidates, including under agreements with third parties, such as consultants and contract research organizations, or CROs;

- the cost of manufacturing drug products for use in our preclinical studies and clinical trials, including under agreements with third parties, such as consultants and contract manufacturing organizations, or CMOs;
- facilities, depreciation and other expenses, which include direct or allocated expenses for rent and maintenance of facilities and insurance;
- costs related to compliance with regulatory requirements; and
- payments made under third-party licensing agreements.

We recognize external development costs based on an evaluation of the progress to completion of specific tasks using information provided to us by our service providers. This process involves reviewing open contracts and purchase orders, communicating with our personnel to identify services that have been performed on our behalf, and estimating the level of service performed and the associated cost incurred for the service when we have not yet been invoiced or otherwise notified of actual costs. Nonrefundable advance payments for goods or services to be received in the future for use in research and development activities are recorded as prepaid expenses. Such amounts are recognized as an expense when the goods have been delivered or the services have been performed, or when it is no longer expected that the goods will be delivered or the services rendered. Upfront payments, milestone payments and annual maintenance fees under license agreements are expensed in the period in which they are incurred.

Our direct research and development expenses are tracked by product candidate and consist primarily of external costs, such as fees paid to outside consultants, CROs, CMOs and research laboratories in connection with our preclinical development, process development, manufacturing and clinical development activities. Our direct research and development expenses by product candidate also include fees incurred under third-party license agreements. We do not allocate employee costs and costs associated with our discovery efforts, laboratory supplies and facilities, including depreciation or other indirect costs, to specific product candidates because these costs are deployed across multiple programs and, as such, are not separately classified. We use internal resources primarily to conduct our research and discovery as well as for managing our preclinical development, process development, manufacturing and clinical development activities. These employees work across multiple programs and, therefore, we do not track our costs by product candidate.

The table below summarizes our research and development expenses incurred by product candidate:

	Three Months Ended March 31,	
	2019	2018
Mavorixafor	$ 2,851	$ 3,010
X4P-002	84	—
X4P-003	8	—
Unallocated research and development expenses	2,712	1,734
Total research and development expenses	$ 5,655	$ 4,744

Research and development activities are central to our business model. Product candidates in later stages of clinical development generally have higher development costs than those in earlier stages of clinical development, primarily due to the increased size and duration of later-stage clinical trials. As a result, we expect that our research and development expenses will increase substantially over the next several years as we plan to initiate a Phase 3 pivotal clinical trial of mavorixafor for the treatment of patients with WHIM syndrome in the second quarter of 2019 and to initiate a Phase 1 clinical trial of mavorixafor in SCN and a Phase 1/2 clinical trial of mavorixafor in WM in 2019. In addition, we expect research and development expenses to increase related to conducting preclinical development and pursuing initial clinical stages of our product candidates X4P-002 and X4P-003.

The successful development and commercialization of our product candidates is highly uncertain. At this time, we cannot reasonably estimate or know the nature, timing and costs of the efforts that will be necessary to complete the preclinical and clinical development of any of our product candidates. This is due to the numerous risks and uncertainties associated with product development and commercialization, including the following:

- the timing and progress of preclinical and clinical development activities;
- the number and scope of preclinical and clinical programs that we decide to pursue;
- our ability to maintain our current research and development programs and to establish new ones;
- establishing an appropriate safety profile with Investigational New Drug, or IND,-enabling studies;
- successful patient enrollment in, and the initiation and completion of, clinical trials;

- the receipt of regulatory approvals from applicable regulatory authorities;
- the successful completion of clinical trials with safety, tolerability and efficacy profiles that are satisfactory to the U.S Food and Drug Administration, or FDA, or any comparable foreign regulatory authority;
- the timing, receipt and terms of any marketing approvals from applicable regulatory authorities;
- our ability to establish new licensing or collaboration arrangements;
- establishing agreements with third-party manufacturers for clinical supply for our clinical trials and commercial manufacturing, if any of our product candidates is approved;
- development and timely delivery of clinical-grade and commercial-grade drug formulations that can be used in our clinical trials and for commercial launch;
- obtaining, maintaining, defending and enforcing patent claims and other intellectual property rights;
- launching commercial sales of our product candidates, if approved, whether alone or in collaboration with others; and
- maintaining a continued acceptable safety profile of the product candidates following approval.

A change in the outcome of any of these variables with respect to the development of our product candidates could significantly change the costs and timing associated with the development of that product candidate. We may never succeed in obtaining regulatory approval for any of our product candidates.

General and Administrative Expenses

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

We anticipate that our general and administrative expenses will increase in the future as we increase our headcount to support our continued research activities and development of our product candidates. We also anticipate that we will incur increased accounting, audit, legal, regulatory, compliance and director and officer insurance costs as well as investor and public relations expenses associated with being a public company.

Other Income (Expense), Net

Interest Income

Interest income consists of interest earned on our cash equivalents, which consist of money market funds. Our interest income has not been significant due to low interest rates earned on invested balances.

Interest Expense

For the three months ended March 31, 2019, interest expense primarily consists of interest on outstanding borrowings under our Hercules Loan Agreement, which was entered into with Hercules Capital, Inc., or Hercules, in October 2018. Interest expense in the current period also includes interest on loans acquired from Arsanis (see discussion of the FFG loan agreement in "Liquidity and Capital Resources"). For the three months ended March 31, 2018, interest expense consisted of interest on outstanding borrowing under the 2016 loan and security agreement with Silicon Valley Bank, or SVB, which we refer to as the SVB Loan Agreement, as well as amortization of debt issuance costs and accretion of a final payment payable upon the maturity or the repayment in full of all obligations under the SVB Loan Agreement. In October 2018, in connection with entering into the Hercules Loan Agreement, all amounts due under the SVB Loan Agreement, including unpaid principal of $4.3 million and a final payment $0.3 million, were repaid with proceeds from the Hercules Loan Agreement, and the SVB Loan Agreement was terminated. We expect that our interest expense will increase in 2019 as compared to 2018 in connection with our Hercules Loan Agreement, under which we borrowed $8.0 million in October 2018 and an additional $2.0 million in December 2018, and as a result of the FFG loan agreement, under which borrowings were $9.5 million as of March 31, 2019.

Change in Fair Value of Preferred Stock Warrant Liability

In connection with our Series A and Series B preferred stock financings in 2015, 2017 and 2018, and entering into the SVB Loan Agreement in 2016 and in connection with entering into the Hercules Loan Agreement in October 2018, we issued warrants to purchase shares of our preferred stock. Due to the liquidation requirements of these preferred shares, we classified these warrants as a liability on our consolidated balance sheet, which was remeasured to fair value at each reporting date with changes in the fair value reported as a component of other income (expense), net in our consolidated statements of operations and comprehensive loss. Upon the closing of the Merger on March 13, 2019, all of our outstanding preferred stock warrants become exercisable for Arsanis common

stock; accordingly, the liability as of March 13, 2019 for these warrants was remeasured to fair value and reclassified to additional paid-in capital. As a result, following the closing of the Merger, we will no longer recognize changes in the fair value of the warrant liability as other income (expense), net in our consolidated statements of operations and comprehensive loss.

Change in Fair Value of Derivative Liability

Our license agreement with Genzyme, a Sanofi company, contains a contingent payment obligation that requires that we make a payment to Genzyme upon a change of control event. The contingent payment obligation meets the definition of a derivative instrument. We classify this derivative as a liability on our consolidated balance sheet that we remeasure to fair value at each reporting date, and we recognize changes in the fair value of the derivative liability as a component of other income (expense), net in our consolidated statement of operations and comprehensive loss. We will continue to recognize changes in the fair value of the derivative liability until a change of control event occurs or until the license agreement is terminated. The Merger with Arsanis qualifies as a change of control event, as defined in the license agreement.

Loss on Preferred Stock Repurchase Liability

In October 2017, we entered into a stock repurchase agreement with a holder of Series Seed preferred stock for the repurchase of shares of Series Seed preferred stock. We concluded that the arrangement was a freestanding financial instrument that was required to be recorded as a liability at fair value. Upon entering into the repurchase agreement, we recorded a preferred stock repurchase liability on our consolidated balance sheet of $587 for the fair value of the financial instrument and recognized a corresponding expense as a component of other income (expense), net in our consolidated statements of operations and comprehensive loss. We subsequently remeasured the repurchase liability to fair value at each reporting date through the settlement date of the repurchase agreement in January 2018 and recognized changes in the fair value of the preferred stock repurchase liability as a component of other income (expense), net in our consolidated statements of operations and comprehensive loss for the three months ended March 31, 2018.

Income Taxes

Since our inception, we have not recorded any income tax benefit for the net losses we have incurred in each year or for our earned research and development tax credits, as we believe, based upon the weight of available evidence, that it is more likely than not that all of our net operating loss carryforwards and tax credits will not be realized. Accordingly, we have recorded a full valuation allowance against our net deferred tax assets at each balance sheet date.

Results of Operations

Comparison of the Three Months Ended March 31, 2019 and 2018

The following table summarizes our results of operations for the three months ended March 31, 2019 and 2018:

	Three Months Ended March 31,		
	2019	2018	Change
	(in thousands)		
Operating expenses:			
Research and development	$ 5,655	$ 4,744	$ 911
General and administrative	4,783	$ 1,366	3,417
Total operating expenses	10,438	6,110	4,328
Loss from operations	(10,438)	(6,110)	(4,328)
Other income (expense):			
Interest income	69	69	—
Interest expense	(399)	(169)	(230)
Change in fair value of preferred stock warrant and derivative liabilities	(105)	(1,157)	1,052
Total other income (expense), net	(435)	(1,257)	822
Net loss	$(10,873)	$(7,367)	$(3,506)

X4 PHARMACEUTICALS, INC.

Research and Development Expenses

	Three Months Ended March 31,		
	2019	2018	Change
	(in thousands)		
Direct research and development expenses by product candidate:			
Mavorixafor (X4P-001)	$ 2,851	$ 3,010	$ (159)
X4P-002	84	—	84
X4P-003	8	—	8
Unallocated research and development expenses:			
Personnel related (including stock-based compensation)	2,200	1,034	1,166
Other	512	699	(187)
Total research and development expenses	$ 5,655	$ 4,744	$ 911

Research and development expenses were $5.7 million for the three months ended March 31, 2019, compared to $4.7 million for the three months ended March 31, 2018. The increase of $1.0 million was primarily due to an increase of $1.0 million in unallocated research and development costs, primarily associated with personnel and other costs associated with the research and development site in Vienna, Austria, acquired in the Merger and an increase of $0.2 million in direct expenses of our mavorixafor development program, partially offset by a net decrease of $0.2 million in external costs related to our product candidates.

Direct expenses of our mavorixafor product candidate decreased by $0.2 million in the three months ended March 31, 2019, compared to the three months ended March 31, 2018. The decrease was primarily due to a decrease in costs associated with product manufacturing and clinical trials as the WHIM Phase 2 and Phase 1/2 for the treatment of patients with clear cell renal cell carcinoma, or ccRCC, wind down. We expect that our research and development expenses for mavorixafor will increase substantially over the next several years as we plan to initiate a Phase 3 pivotal clinical trial of mavorixafor for the treatment of patients with WHIM syndrome in the second quarter of 2019 and to initiate a Phase 1 clinical trial of mavorixafor in SCN and a Phase 1/2 clinical trial of mavorixafor in WM in 2019.

Direct expenses of our X4P-002 product candidate increased $0.1 million in three months ended March 31, 2019, compared to the three months ended March 31, 2018. We had no direct costs related to the X4P-002 product candidate during the three months ended March 31, 2018 as we paused the development of X4P-002 in favor of focusing our resources on the development of our mavorixafor product candidate. We expect that our research and development expenses for X4P-002 will increase over the next several years as we resume work on X4P-002's preclinical development and initial clinical stage activities.

Unallocated research and development expenses were $2.7 million for the three months ended March 31, 2019, compared to $1.7 million for the three months ended March 31, 2018. The increase of $1.0 million was primarily due to an increase of $1.2 million in personnel-related costs due to the hiring of additional personnel in our research and development function, partially offset by a net decrease of $0.2 million in external costs related to our product candidates.

General and Administrative Expenses

General and administrative expenses were $4.8 million for the three months ended March 31, 2019, compared to $1.4 million for the three months ended March 31, 2018. The increase of $3.4 million was primarily due to a $1.9 million increase in professional fees and a $1.4 million increase in personnel-related costs. Professional fees increased due to higher audit, legal and market research expenses particularly related to the merger, as well as legal costs incurred in connection with maintaining and registering worldwide patents and costs associated with our ongoing business operations. Personnel-related costs for the three months ended March 31, 2019 and 2018 included stock-based compensation of $0.3 million and $0.1 million, respectively.

Other Income (Expense), Net

Other income (expense), net was $0.4 million of expense during the three months ended March 31, 2019, compared to $1.3 million of expense for the three months ended March 31, 2018. The decrease in other expense, net was primarily due to a $1.1 million decrease in the net expense generated from the change in the fair value of our preferred stock warrant and derivative liabilities in the three months ended March 31, 2019, partially offset by a $0.2 million increase in interest expense.

Liquidity and Capital Resources

Since our inception, we have not generated revenue from any sources, including from product sales, and have incurred significant operating losses and negative cash flows from our operations. We have funded our operations to date primarily with proceeds from sales of common stock and warrants, sales of preferred stock, proceeds from the issuance of convertible debt and borrowings under loan and security agreements. Through March 31, 2019, we have received net proceeds of $73.7 million from sales of our preferred stock, including proceeds from convertible debt, which converted into preferred stock, and gross proceeds of $6.0 million from borrowings under the SVB Loan Agreement. In 2018, we received gross proceeds of $10.0 million from borrowings under the Hercules Loan Agreement and repaid all amounts due under the SVB Loan Agreement. In March 2019, we completed the Merger with Arsanis and acquired $26.4 million of cash, cash equivalents and restricted cash owned by Arsanis. On April 16, 2019, we raised $78.9 million, after deducting underwriting discounts and estimated offering costs, through the sale of 5,670,000 shares of common stock and, in lieu of common stock, pre-funded warrants to purchase 2,130,000 shares of common stock, and accompanying Class A warrants to purchase 3,900,000 shares of our common stock at a price to the public of $11.00 per share and accompanying Class A warrants (or $10.999 per pre-funded warrant and accompanying Class A warrants).

Cash Flows

The following table summarizes our sources and uses of cash for each of the periods presented:

	Three Months Ended March 31,	
	2019	2018
	(in thousands)	
Net cash used in operating activities	$(11,750)	$(6,182)
Net cash provided by investing activities	26,406	—
Net cash provided by (used in) financing activities	113	(1,660)
Impact of foreign exchange on cash and restricted cash	(21)	—
Net increase (decrease) in cash, cash equivalents and restricted cash	$ 14,748	$(7,842)

Operating Activities

During the three months ended March 31, 2019, net cash used in operating activities was $11.8 million of cash, resulting from our net loss of $10.9 million, and net cash used in changes in our operating assets and liabilities of $1.5 million, partially offset by noncash expenses of $0.6 million. Net cash used in changes in our operating assets and liabilities for the three months ended March 31, 2019 consisted of a $0.6 million increase in prepaid expenses and other current assets, a $2.0 million decrease in accrued expenses, and a $0.2 million decrease in lease liabilities, partially offset by a $1.3 million increase in accounts payable. The increase in prepaid expenses and other current assets was primarily due to increases in prepaid insurance amounts. The decrease in accrued expenses was primarily due to payments of employee bonuses and payments to vendors related to professional fees and services. The increase in accounts payable was primarily due to the timing of vendor invoicing and payments.

During the three months ended March 31, 2018, operating activities used $6.2 million of cash resulting from our net loss of $7.4 million, and net cash used in changes in our operating assets and liabilities of $0.2 million, offset by non-cash expenses of $1.3 million. Net cash used in changes in our operating assets and liabilities for the three months ended March 31, 2018 consisted of a $0.6 million decrease in accounts payable and a $0.2 million decrease in lease liabilities, partially offset by a $0.2 million decrease in prepaid expenses and other current assets and a $0.3 million increase in accrued expenses. The decrease in accounts payable was primarily due to timing of vendor invoicing and payments. The decrease in lease liabilities was primarily due to lease payments related to the Cambridge office lease. The decrease in prepaid expenses and other current assets was primarily due to the expensing of prepaid amounts paid to CROs for preclinical development and clinical trial activities. The increase in accrued expenses was primarily due to higher professional fees and increases in research and development activities and costs.

Investing Activities

During the three months ended March 31, 2019, net cash provided by investing activities consisted primarily of $26.4 million of cash and restricted cash acquired in connection with the Merger. There was no net cash provided by investing activities during the three months ended March 31, 2018.

Financing Activities

During the three months ended March 31, 2019, net cash provided by financing activities was $0.1 million, consisting primarily of the exercise of stock options.

During the three months ended March 31, 2018, net cash used in financing activities was $1.7 million, consisting primarily of $1.1 million in the repurchase of Series Seed convertible preferred stock, principal repayments of $0.5 million under the SVB Loan Agreement, and $0.1 million in payments of issuance costs related to convertible preferred stock.

Loan and Security Agreements

Loan and Security Agreement with Silicon Valley Bank

In October 2016, we entered into the SVB Loan Agreement, which provided for aggregate maximum borrowings of up to $10.0 million, consisting of a term loan of up to $6.0 million, which we borrowed in June 2017, and, subject to specified conditions, an additional term loan of up to $4.0 million available for borrowing until December 31, 2017. In October 2018, in connection with entering into the Hercules Loan Agreement as described below, we terminated the SVB Loan Agreement and repaid all amounts due under the SVB Loan Agreement, including unpaid principal of $4.3 million, a final payment of $0.3 million, a prepayment premium of $87 thousand and accrued interest of $23 thousand. We accounted for the repayment of amounts as an extinguishment of the SVB Loan Agreement and recognized a loss on extinguishment of debt of $0.2 million within other income (expense), net in the consolidated statement of operations and comprehensive loss. The loss on extinguishment of debt was calculated as the difference between the reacquisition price of the borrowings under the SVB Loan Agreement of $4.7 million and the carrying value of the debt under the SVB Loan Agreement of $4.5 million. Our annual effective interest rate of the SVB Loan Agreement was approximately 11.8% the period from January 1, 2018 through the date of repayment of all borrowings under the SVB Loan Agreement.

Loan and Security Agreement with Hercules Capital, Inc.

In October 2018, we entered into the Hercules Loan Agreement, which provided for aggregate borrowings of up to $13.0 million, consisting of (i) a term loan of up to $8.0 million, which was available upon entering into the agreement, (ii) subject to specified financing conditions, an additional term loan of up to $2.0 million, available for borrowing from January 1, 2019 to March 31, 2019, and (iii) subject to specified financing conditions and the receipt of the second tranche $2.0 million term loan described above, an additional term loan of up to $3.0 million, available for borrowing until March 31, 2019. In October 2018, we borrowed $8.0 million under the Hercules Loan Agreement.

In December 2018, we entered into the First Amendment to the Hercules Loan Agreement (the "First Amendment"), which amended the available borrowing dates of the second tranche from between January 1, 2019 and March 31, 2019 to between December 11, 2018 and December 14, 2018 and amended the term loan maturity date to November 1, 2021. In December 2018, we borrowed the additional $2.0 million provided under the Hercules Loan Agreement, as amended by the First Amendment.

In March 2019, the conditions necessary for borrowing the remaining $3.0 million under the Hercules Loan Agreement were not met and the borrowing capacity expired at that time.

Borrowings under the Hercules Loan Agreement bear interest at variable rates, with the first tranche bearing interest at a variable rate equal to the greater of (i) 9.5% or (ii) 9.5% plus *The Wall Street Journal* prime rate minus 5.25%, the second tranche bearing interest at a variable rate, subject to completion of specified financing conditions, equal to either (A) the greater of (i) 9.5% or (ii) 9.5% plus *The Wall Street Journal* prime rate minus 5.25% or (B) the greater of (i) 8.75% or (ii) 8.75% plus *The Wall Street Journal* prime rate minus 5.25%, and the third tranche bearing interest at a variable rate equal to the greater of (i) 8.75% or (ii) 8.75% plus *The Wall Street Journal* prime rate minus 5.25%. In an event of default, as defined, and until such event is no longer continuing, the interest rate applicable to borrowings under the Hercules Loan Agreement would be increased by 4.0%. As of March 31, 2019 and December 31, 2018, the interest rate applicable to borrowings under the Hercules Loan Agreement was 9.75%.

Borrowings under the Hercules Loan Agreement are repayable in monthly interest-only payments through August 2019, or a later date upon achievement of specified conditions, and in equal monthly payments of principal and accrued interest from September 2019 until the maturity date of the loan, which is either, (i) if the second tranche is not borrowed, November 2021 or, (ii) if the second tranche is

borrowed, May 2022. At our option, we may prepay all, but not less than all, of the outstanding borrowings, subject to a prepayment premium of up to 2.0% of the principal amount outstanding as of the date of repayment. The Hercules Loan Agreement also provides for a final payment, payable upon maturity or the repayment in full of all obligations under the agreement, of up to $953. An aggregate final payment of $794 payable in connection with the $8,000 term loan and the $2,000 term loan is being accreted to interest expense to increase the carrying value of the debt over the term of the loan using the effective interest method.

In addition, the Hercules Loan Agreement contains a redemption feature that, upon an event of default, provides Hercules the option to accelerate and demand repayment of the debt, including a prepayment premium. We concluded that the redemption feature meets the definition of a derivative instrument as the repayment of the debt contains a substantial premium, resulting in the redemption feature not being clearly and closely related to the host instrument. We recorded the issuance-date fair value of the derivative liability of $18 as a debt discount and as a derivative liability on our consolidated balance sheet.

Borrowings under the Hercules Loan Agreement are collateralized by substantially all of our personal property and other assets, including our intellectual property until a specified financing condition is met. Under the Hercules Loan Agreement, we have agreed to affirmative and negative covenants to which we will remain subject until maturity or repayment in full. The covenants include maintaining a minimum liquidity amount of the lesser of (i) 125% of outstanding borrowings under the Hercules Loan Agreement and (ii) 100% of our cash and cash equivalents in an account in which Hercules has a first priority security interest as well as restrictions on our ability to incur additional indebtedness, pay dividends, encumber our intellectual property, or engage in certain fundamental business transactions, such as mergers or acquisitions of other businesses. Obligations under the Hercules Loan Agreement are subject to acceleration upon occurrence of specified events of default, including payment default, insolvency and a material adverse change in our business, operations or financial or other condition.

In connection with entering into the Hercules Loan Agreement in October 2018, we issued to Hercules warrants for the purchase of 210,638 shares of Series B convertible preferred stock at an exercise price of $1.88 per share. These warrants were immediately exercisable and expire in October 2028.

In connection with entering into the First Amendment in December 2018, we agreed to issue to Hercules warrants for the purchase of a specified number of shares of convertible preferred stock or, if issued following the Merger with Arsanis, a specified number of shares of common stock of the combined organization, at an aggregate exercise price of $99,000. The warrants were to be issued at the earliest of (i) June 30, 2019, (ii) the earlier to occur of (a) the date we prepay the outstanding borrowings or (b) the date the outstanding borrowings become due and payable, or (iii) on or before the fifth business day following the closing of or the announcement of the termination of our merger with Arsanis. The number of shares of convertible preferred stock issuable upon exercise of these warrants was determined to be 52,659 shares, calculated by dividing $99,000 by the $1.88 price per share paid by investors that purchased shares of Series B convertible preferred stock in September 2018. On March 18, 2019, as a result of the closing of the Merger with Arsanis on March 13, 2019, we issued to Hercules warrants for the purchase of 5,000 shares of common stock of the combined organization at an exercise price of $19.80 per share, each of which reflected the share Exchange Ratio of 1-for-0.5702 applied in the Merger as well as the 6-for-1 reverse stock split effected by the combined organization on March 13, 2019.

On October 19, 2018 and December 11, 2018, the dates we entered into the Hercules Loan Agreement and the First Amendment, respectively, we recorded the aggregate initial fair value of the warrants of $0.1 million as a preferred stock warrant liability, with a corresponding amount recorded as a debt discount on our consolidated balance sheet. As of March 13, 2019, the fair value of the warrants was $0.3 million.

In connection with entering into the Hercules Loan Agreement and the First Amendment, we also paid Hercules $92,000 of upfront fees, including facility, due diligence and legal fees associated with entering into the agreement, which were also recorded as a debt discount. The debt discount is reflected as a reduction of the carrying value of long-term debt on our consolidated balance sheet and is being amortized to interest expense over the term of the loan using the effective interest method.

We recognized aggregate interest expense under the Hercules Loan Agreement of $0.3 million and $0 during three months ended March 31, 2019 and 2018, respectively, which included non-cash interest expense of $0.1 million related to the accretion of the debt discount and the final payment. As of March 31, 2019, and December 31, 2018, the unamortized debt discount was $0.2 million and $0.2 million, respectively. The annual effective interest rate of the Hercules Loan Agreement as of March 31, 2019 and December 31, 2018 was approximately 14.2%, respectively.

FFG Borrowings

Between September 2011 and March 2017, Arsanis GmbH, a subsidiary of Arsanis, entered into a series of funding agreements with Österreichische Forschungsförderungsgesellschaft mbH, or FFG, that provided for loans and grants to fund qualifying research and development expenditures of Arsanis GmbH on a project-by-project basis, as approved by FFG. As of March 31, 2019, the outstanding principal amount under loans from FFG was $9.5 million, including $2.9 million of current portion.

On February 4, 2019, Arsanis GmbH, received letters from counsel to FFG alleging that we breached reporting, performance and other obligations in connection with the grants and loans made by FFG to Arsanis GmbH between September 2011 and March 2017 to fund qualifying research and development expenditures. The letters demanded the immediate repayment of all such subsidies. On March 8, 2019, Arsanis announced that it had entered into a settlement agreement, or the Settlement Agreement, with FFG in respect of these allegations and demands for repayment. Pursuant to the terms of the Settlement Agreement, in exchange for FFG's waiver of all claims against Arsanis and Arsanis GmbH except for its claims for repayment of the loans and regular interest, including its waiver of claims for repayment of grants and interest exceeding regular interest, subject to compliance by us and Arsanis GmbH with the terms of the Settlement Agreement, Arsanis GmbH has agreed to repay the outstanding loan principal (plus regular interest accrued thereon) on an accelerated payment schedule of three years instead of the original five years, with the final accelerated installment due and payable on June 30, 2021. The Settlement Agreement also contains certain other restrictive covenants, including a requirement to maintain, as of April 30, 2019, a minimum cash balance equal to 70% of the then-outstanding principal amount of the loans at Arsanis GmbH in an account held with an Austrian bank, until all of the loans have been repaid and subject to other terms specified in the Settlement Agreement.

Amounts due under the FFG loans bear interest at varying fixed rates ranging from 0.75% to 2.0% per annum. Interest is payable semi-annually in arrears, with all accrued interest and principal due upon maturity. After giving effect to the Settlement Agreement, the FFG loans mature at varying dates between March 2019 and June 2021. The FFG loans are not secured by any of our assets. We may be required to return all or a portion of the FFG loans and/or grants if we do not comply with the terms of the related FFG funding agreements and related guidelines, including specified requirements as to continued operations with respect to certain locations and funded projects, or if we fail to comply with the terms of the Settlement Agreement.

Funding Requirements

We expect our expenses to increase substantially in connection with our ongoing activities, particularly as we advance the preclinical activities and clinical trials of our product candidates in development. In addition, following the closing of the Merger, we expect to incur additional costs associated with operating as a public company. The timing and amount of our operating expenditures will depend largely on:

- the scope, number, initiation, progress, timing, costs, design, duration, any potential delays, and results of clinical trials and nonclinical studies for our current or future product candidates, particularly our Phase 3 pivotal clinical trial of mavorixafor for the treatment of patients with WHIM syndrome, our Phase 1 clinical trial of mavorixafor in SCN and our Phase 1/2 clinical trial of mavorixafor in WM, [*and our Phase 1/2 for the treatment of ccRCC*]
- the clinical development plans we establish for these product candidates;
- the number and characteristics of product candidates and programs that we develop or may in-license;
- the outcome, timing and cost of regulatory reviews, approvals or other actions to meet regulatory requirements established by the FDA and comparable foreign regulatory authorities, including the potential for the FDA or comparable foreign regulatory authorities to require that we perform more studies for our product candidates than those that we currently expect;
- our ability to obtain marketing approval for our product candidates;
- the cost of filing, prosecuting, defending and enforcing our patent claims and other intellectual property rights covering our product candidates, including any such patent claims and intellectual property rights that we have licensed from Genzyme pursuant to the terms of our license agreement with Genzyme;
- our ability to maintain, expand and defend the scope of our intellectual property portfolio, including the cost of defending intellectual property disputes, including patent infringement actions brought by third parties against us or our product candidates;
- the cost and timing of completion of commercial-scale outsourced manufacturing activities with respect to our product candidates;
- our ability to establish and maintain licensing, collaboration or similar arrangements on favorable terms and whether and to what extent we retain development or commercialization responsibilities under any new licensing, collaboration or similar arrangement;
- the cost of establishing sales, marketing and distribution capabilities for any product candidates for which we may receive regulatory approval in regions where we choose to commercialize our products on our own;

- the success of any other business, product or technology that we acquire or in which we invest;
- the costs of acquiring, licensing or investing in businesses, product candidates and technologies;
- our need and ability to hire additional management and scientific and medical personnel;
- the costs to operate as a public company in the United States, including the need to implement additional financial and reporting systems and other internal systems and infrastructure for our business;
- market acceptance of our product candidates, to the extent any are approved for commercial sale; and
- the effect of competing technological and market developments.

We expect that our existing cash and cash equivalents, including $78.9 million of net proceeds from our April 2019 public offering and the cash acquired from Arsanis will be sufficient to fund our operating expenses, capital expenditure requirements and debt service payments for at least the next 12 months.

Until such time, if ever, as we can generate substantial product revenue, we expect to finance our cash needs through a combination of equity offerings, debt financings, collaborations, strategic alliances, and marketing, distribution or licensing arrangements with third parties. In January 2019, Arsanis filed a universal shelf registration statement on Form S-3 with the SEC, which was declared effective in February 2019, and pursuant to which Arsanis registered for sale up to $150 million of any combination of our common stock, preferred stock, debt securities, warrants and/or units from time to time and at prices and on terms that we may determine. Subsequently, in April 2019, we sold 5,670,000 shares of common stock and, in lieu of common stock, pre-funded warrants to purchase 2,130,000 shares of common stock, and accompanying Class A warrants to purchase 3,900,000 shares of our common stock at a price to the public of $11.00 per share and accompanying Class A warrants (or $10.999 per pre-funded warrant and accompanying Class A warrants) under this shelf registration statement for gross proceeds of approximately $85.8 million. As of May 1, 2019, approximately $64.2 million of securities remain available for issuance under the shelf registration statement. To the extent that we raise additional capital through the sale of equity or convertible debt securities, the ownership interest of our stockholders may be materially diluted, and the terms of such securities could include liquidation or other preferences that adversely affect the rights of our stockholders. Debt financing and preferred equity financing, if available, may involve agreements that include restrictive covenants that limit our ability to take specified actions, such as incurring additional debt, making capital expenditures or declaring dividends. If we raise funds through collaborations, strategic alliances or marketing, distribution or licensing arrangements with third parties, we may have to relinquish valuable rights to our technologies, future revenue streams, research programs or product candidates or grant licenses on terms that may not be favorable to us. If we are unable to raise additional funds through equity or debt financings or other arrangements when needed, we may be required to delay, reduce or eliminate our product development or future commercialization efforts, or grant rights to develop and market product candidates that we would otherwise prefer to develop and market ourselves.

Critical Accounting Policies and Significant Judgments and Estimates

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

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

Accrued Research and Development Expenses

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

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

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

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

Stock-Based Compensation

Historically, we measured all stock-based awards granted to employees and directors based on the fair value on the date of the grant and recognize compensation expense for those awards, net of estimated forfeitures, over the requisite service period, which is generally the vesting period of the respective award. We issue stock-based awards with only service-based vesting conditions and record the expense for these awards using the straight-line method. We have not issued any stock-based awards with performance-based vesting conditions.

For stock-based awards granted to non-employee consultants, compensation expense is recognized over the period during which services are rendered by such non-employee consultants until completed. At the end of each financial reporting period prior to completion of the service, the fair value of these awards is remeasured using the then-current fair value of our common stock and updated assumption inputs in the Black-Scholes option-pricing model.

The fair value of each stock option grant is estimated on the date of grant using the Black-Scholes option-pricing model, which uses as inputs the fair value of our common stock and assumptions we make for the volatility of our common stock, the expected term of the stock options, the risk-free interest rate for a period that approximates the expected term of our stock options and their expected dividend yield.

Prior to the closing of the Merger and the listing of our common stock on the Nasdaq Capital Market, our board of directors historically determined, as of the date of each option grant, with input from our management, the assistance of a third-party valuation specialist and the guidance outlined in the American Institute of Certified Public Accountants' Accounting and Valuation Guide, Valuation of Privately-Held-Company Equity Securities Issued as Compensation, the estimated fair value of our common stock on the date of grant based on a number of objectives and subjective factors

Since the Merger and the listing of our common stock on the Nasdaq Capital Market, we have relied on the market price of our common stock to determine the fair value on the date of grant for purposes of determining our stock-based compensation expense.

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

Valuation of Preferred Stock Warrant Liability

In connection with our preferred stock financings in 2015, 2017, and 2018, and entering into the SVB Loan Agreement in 2016, we issued warrants to purchase shares of our preferred stock. We classify these warrants as liabilities on our consolidated balance sheets because these warrants are freestanding financial instruments that may require us to transfer assets upon exercise. The warrant liability was initially recorded at fair value upon the date of issuance of each warrant and is subsequently remeasured to fair value at each reporting date. Changes in the fair value of the warrant liability are recognized as a component of other income (expense), net in our consolidated statements of operations and comprehensive loss. Upon the closing of the Merger on March 13, 2019, all of our outstanding preferred stock warrants become exercisable for Arsanis common stock; accordingly, the liability as of March 13, 2019 for these warrants was remeasured to fair value and reclassified to additional paid-in capital. As a result, following the closing of the Merger, we no longer recognize changes in the fair value of the warrant liability as other income (expense), net in our consolidated statement of operations and comprehensive loss.

To value the preferred stock warrants, we used various valuation methods, including the Monte Carlo method, the option-pricing method and the hybrid method, all of which incorporate assumptions and estimates, We assess these assumptions and estimates on a quarterly basis as additional information impacting the assumptions is obtained. Estimates and assumptions impacting the fair value measurement include the fair value per share of the underlying shares of our Series A and Series B preferred stock, risk-free interest rate, expected dividend yield, expected volatility of the price of the underlying preferred stock, and the remaining contractual term of the warrants (except for the warrants that would be automatically exercised upon an initial public offering, in which case the remaining estimated term to automatic exercise was used). The most significant assumption in the Monte Carlo method, the option-pricing method and the hybrid method impacting the fair value of the preferred stock warrants is the fair value of our preferred stock as of each remeasurement date. We determine the fair value per share of the underlying preferred stock by taking into consideration the most recent sales of our preferred stock, results obtained from third-party valuations and additional factors that are deemed relevant.

Upon the closing of the Merger, pursuant to the Merger Agreement, all of our outstanding preferred stock warrants have become exercisable for Arsanis common stock; accordingly, the fair value of the warrant liability for these warrants at that time will be reclassified to additional paid-in capital. As a result, following the closing of the Merger, we will no longer recognize changes in the fair value of the warrant liability as other income (expense), net in our consolidated statement of operations and comprehensive loss.

Valuation of Derivative Liability

Our license agreement with Genzyme contains a contingent payment obligation that requires that we make a cash payment to Genzyme upon a change of control event. The contingent payment obligation meets the definition of a derivative instrument as the contingent payment obligation is not clearly and closely related to our host instrument and is a cash-settled liability. Accordingly, we classify this derivative as a liability on our consolidated balance sheet. The derivative liability was initially recorded at fair value on the date of entering into the license agreement and is subsequently remeasured to fair value at each reporting date. Changes in the fair value of the derivative liability are recognized as a component of other income (expense), net in our consolidated statement of operations and comprehensive loss. The Merger qualifies as a change of control event, as defined in the license agreement, but results in no payment being due to Genzyme under the license agreement. On March 13, 2019, the closing date of the Merger with Arsanis, this derivative liability was remeasured to fair value, which was $0, and subsequent changes in fair value will no longer be recognized in the consolidated statements of operations and comprehensive loss because the contingent payment obligation expired at that time.

The fair value of the derivative liability was estimated at each reporting date based, in part, on the results of third-party valuations, which were prepared using the option-pricing method or the hybrid method, each of which considered as inputs the type, timing and probability of the occurrence of a change of control event, the potential amount of the payment under potential exit scenarios, the fair value per share of the underlying common stock and the risk-adjusted discount rate.

Valuation of Preferred Stock Repurchase Liability

In October 2017, we entered into a stock repurchase agreement with a holder of Series Seed preferred stock for the repurchase of shares of Series Seed preferred stock. We classified this repurchase agreement as a liability on our consolidated balance sheet as the repurchase agreement was a freestanding financial instrument that required us to transfer assets upon settlement. The preferred stock repurchase liability was initially recorded at fair value on the date of entering into the repurchase agreement and was subsequently remeasured to fair value at each reporting date and upon the settlement date until the settlement of the repurchase agreement, which occurred in January 2018. Changes in the fair value of the preferred stock repurchase liability were recognized as a component of other income (expense), net in our consolidated statement of operations and comprehensive loss. The fair value of the preferred stock repurchase liability was estimated by multiplying (i) the 598,975 shares of Series Seed preferred stock that we agreed to repurchase by (ii) the difference between the agreed repurchase price of $1.88 per share and the fair value per share of the Series Seed preferred stock, which result approximated the fair value of the preferred stock repurchase liability given the short duration of the contract. We determined the fair value per share of the Series Seed preferred stock by taking into consideration the most recent sales of our preferred stock, results obtained from third-party valuations and additional factors that were deemed relevant. In January 2018, the Series Seed preferred stock repurchase agreement was settled through our repurchase of the shares.

Emerging Growth Company Status

We are an "emerging growth company," or EGC, as defined in the Jumpstart Our Business Startups Act of 2012, or the JOBS Act, We will remain an EGC until the earlier of (1) the last day of the fiscal year following the fifth anniversary of the completion of Arsanis' initial public offering (December 31, 2022), (2) the last day of the fiscal year in which we have total annual gross revenue of at least $1.07 billion, (3) the last day of the fiscal year in which we are deemed to be a "large accelerated filer" as defined in Rule 12b-2 under the Exchange Act, which would occur if the market value of our common stock held by non-affiliates exceeded $700.0 million as of the last business day of the second fiscal quarter of such fiscal year or (4) the date on which we have issued more than $1.0 billion in non-convertible debt securities during the prior three-year period. The JOBS Act permit an EGC to take advantage of an extended transition period to comply with new or revised accounting standards applicable to public companies until those standards would otherwise apply to private companies. We have irrevocably elected to "opt out" of this provision and, as a result, we will comply with new or revised accounting standards when they are required to be adopted by public companies that are not emerging growth companies.

Off-Balance Sheet Arrangements

We did not have during the periods presented, and we do not currently have, any off-balance sheet arrangements, as defined in the rules and regulations of the SEC.

Recently Issued Accounting Pronouncements

A description of recently issued accounting pronouncements that may potentially impact our financial position and results of operations is disclosed in Note 2 to our consolidated financial statements included elsewhere in this quarterly report on Form 10-Q.

Item 3. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK

Not required for smaller reporting companies.

Item 4. CONTROLS AND PROCEDURES

Evaluation of Disclosure Controls and Procedures

Our principal executive officer and principal financial officer, after evaluating the effectiveness of our disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) as of the end of the period covered by this Form 10-Q, have concluded that, based on such evaluation, our disclosure controls and procedures were effective to ensure that information required to be disclosed by us in the reports that we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the SEC's rules and forms, and is accumulated and communicated to our management, including our principal executive and principal financial officers, or persons performing similar functions, as appropriate, to allow timely decisions regarding required disclosure.

Changes in Internal Controls

During the three months ended March 31, 2019, we implemented certain internal controls as a result of our adoption of the new lease standard on January 1, 2019 as well as internal controls related to the business combination. There were no other changes in our internal control over financial reporting (as defined in Rules 13a–15(f) and 15d–15(f) under the Exchange Act) that occurred during the three months ended March 31, 2019 that have materially affected, or are reasonably likely to materially affect, our internal control over financial reporting.

X4 PHARMACEUTICALS, INC.

PART II: OTHER INFORMATION

Item 1. LEGAL PROCEEDINGS

We are not currently a party to any material legal proceedings.

Item 1A. RISK FACTORS

There have been no material changes to the risk factors described in our Annual Report on Form 10-K for the year ended December 31, 2018 filed with the SEC on March 11, 2019, as updated by the risk factors described in our Current Report on Form 8-K, filed with the SEC on April 11, 2019.

Item 2. UNREGISTERED SALES OF EQUITY SECURITIES AND USE OF PROCEEDS

Unregistered Sales of Equity Securities

Pursuant to our loan and security agreement, dated as of October 19, 2018, with Hercules Capital, Inc., or Hercules, we issued a warrant to purchase 5,000 shares of our common stock to Hercules having an exercise price of $19.80 per share, subject to adjustment as a result of any stock splits, stock dividends or similar transactions. These warrants were issued in reliance on the exemption from registration provided under Section 4(a)(2) of the Securities Act.

Issuer Purchases of Equity Securities

We did not repurchase any of our equity securities during the quarter ended March 31, 2019.

Use of Proceeds from Registered Securities

On November 20, 2017, Arsanis closed its initial public offering, in which Arsanis issued and sold 666,667 shares of common stock at a public offering price of $60.00 per share, and issued an additional 100,000 shares of common stock at a price of $60.00 per share pursuant to the exercise of the underwriters' over-allotment option. The aggregate gross proceeds to Arsanis from the initial public offering, inclusive of the over-allotment exercise, were $46.0 million. All of the shares of common stock issued and sold in the initial public offering were registered under the Securities Act of 1933, as amended, pursuant to a registration statement on Form S-1 (Registration No. 333-221050), which was declared effective by the SEC on November 15, 2017.

The aggregate net proceeds to Arsanis from the public offering, inclusive of the over-allotment exercise, were approximately $39.5 million, after deducting underwriting discounts and commissions and offering expenses payable by Arsanis of approximately $6.5 million. No offering expenses were paid directly or indirectly to any of Arsanis's directors or officers (or their associates) or persons owning 10% or more of any class of our equity securities or to any other affiliates.

As of March 31, 2019, we have used all of the net proceeds from the initial public offering to advance product candidates through clinical trial programs and for working capital and general corporate purposes. There have been no material changes in the planned use of proceeds from the initial public offering as described in Arsanis's final prospectus filed with the SEC on November 17, 2017 pursuant to Rule 424(b).

Item 3. DEFAULTS UPON SENIOR SECURITIES

Not applicable.

Item 4. MINE SAFETY DISCLOSURES

Not applicable.

Item 5. OTHER INFORMATION

Not applicable.

X4 PHARMACEUTICALS, INC.

Item 6. EXHIBITS

Exhibit No.	Exhibit Description	Filed Herewith	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
2.1	Second Amendment to Agreement and Plan of Merger, dated March 8, 2019, by and among the Company, Artemis AC Corp. and X4 Therapeutics, Inc. (formerly X4 Pharmaceutical, Inc.).		8-K (Exhibit 2.1)	3/8/2019	001-38295
3.1	Restated Certificate of Incorporation of the Company.		8-K (Exhibit 3.1)	11/20/2017	001-38295
3.2	Certificate of Amendment (Reverse Stock Split) to the Restated Certificate of Incorporation of the Company.		8-K (Exhibit 3.1)	3/13/2019	001-38295
3.3	Certificate of Amendment (Name Change) to the Restated Certificate of Incorporation of the Company.		8-K (Exhibit 3.2)	3/13/2019	001-38295
4.1	Form of Common Stock Certificate.		8-K (Exhibit 4.1)	3/13/2019	001-38295
4.2	Form of Warrant to Purchase Series A Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) issued to Silicon Valley Bank and Life Science Loans, LLC.		8-K (Exhibit 4.2)	3/13/2019	001-38295
4.3	Form of Warrant to Purchase Series A Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) issued to Maxim Partners LLC.		8-K (Exhibit 4.3)	3/13/2019	001-38295
4.4	Form of Warrant to Purchase Series B Preferred Stock of X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.).		8-K (Exhibit 4.4)	3/13/2019	001-38295
4.5	Amended and Restated Warrant Agreement, dated as of March 29, 2019, by and between the Company and Hercules Capital, Inc.	X			
4.6	Warrant Agreement, dated as of March 18, 2019, by and between the Company and Hercules Capital, Inc.	X			
10.1.1*	2015 Employee, Director and Consultant Equity Incentive Plan, as amended.		8-K (Exhibit 10.1.1)	3/13/2019	001-38295
10.1.2*	Form of Stock Option Agreement under the 2015 Employee, Director and Consultant Equity Incentive Plan, as amended.		8-K/A (Exhibit 10.1.2)	4/3/2019	001-38295
10.2*	Director Compensation Policy.		8-K (Exhibit 10.2)	3/13/2019	001-38295
10.3*	Amended and Restated Executive Employment Agreement, dated as of March 13, 2019, by and between the Company and Paula Ragan, Ph.D.		8-K (Exhibit 10.3)	3/13/2019	001-38295
10.4*	Amended and Restated Executive Employment Agreement, dated as of March 13, 2019, by and between the Company and Adam S. Mostafa.		8-K (Exhibit 10.4)	3/13/2019	001-38295
10.5±	License Agreement, dated as of July 10, 2014, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, LLC) and Genzyme Corp., a Sanofi company.		8-K/A (Exhibit 10.5)	5/13/2019	001-38295
10.6±	Amendment No. 1 to License Agreement, dated as of October 23, 2014, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Genzyme Corporation, a Sanofi company.		8-K/A (Exhibit 10.6)	5/13/2019	001-38295

X4 PHARMACEUTICALS, INC.

Exhibit No.	Exhibit Description	Filed Herewith	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
10.7±	License Agreement, dated as of December 13, 2016, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Georgetown University.		8-K/A (Exhibit 10.7)	5/13/2019	001-38295
10.8±	Exclusive License Agreement, dated as of December 23, 2016, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Beth Israel Deaconess Medical Center.		8-K/A (Exhibit 10.8)	5/13/2019	001-38295
10.9	Loan and Security Agreement, dated as of October 19, 2018, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Hercules Capital, Inc.		8-K (Exhibit 10.9)	3/13/2019	001-38295
10.10	Amendment No. 1 to Loan and Security Agreement, dated as of December 11, 2018, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Hercules Capital, Inc.		8-K (Exhibit 10.10)	3/13/2019	001-38295
10.11	Lease, dated as of January 20, 2017, by and between X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.) and Brickman 955 Massachusetts LLC.		8-K (Exhibit 10.11)	3/13/2019	001-38295
10.12	Settlement Agreement, dated as of March 8, 2019, by and among X4 Pharmaceuticals, Inc. (formerly Arsanis, Inc.), Artemis AC Corp., X4 Therapeutics, Inc. (formerly X4 Pharmaceuticals, Inc.), Arsanis Biosciences GmbH and Österreichische Forschungsförderungsgesellschaft GmbH.		8-K (Exhibit 10.1)	4/11/2019	001-38295
10.13	Lease Termination Agreement, dated February 26, 2019, by and between Arsanis Biosciences GmbH and Wüstenrot Marxbox GmbH & Co. OG (as successor-in-interest to Marxbox Bauprojekt GmbH & Co. OG), as amended (English translation).		8-K (Exhibit 10.1)	3/1/2019	001-38295
10.14*	Form of Restricted Stock Agreement under the 2017 Equity Incentive Plan.	X			
10.15*	Form of Nonstatutory Stock Option Agreement (Director Grants) under the 2017 Equity Incentive Plan.	X			
10.16*	Form of Nonstatutory Stock Option Agreement under the 2017 Equity Incentive Plan.	X			
10.17*	Form of Incentive Stock Option Agreement under the 2017 Equity Incentive Plan.	X			
31.1	Certification of the Registrant's Principal Executive Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002.	X			
31.2	Certification of the Registrant's Principal Financial Officer pursuant to Section 302 of the Sarbanes-Oxley Act of 2002.	X			
32.1	Certification of Principal Executive Officer and Principal Financial Officer pursuant to Section 906 of the Sarbanes-Oxley Act of 2002.	X			
101	The following materials from the Registrant's Quarterly Report on Form 10-Q for the quarter ended March 31, 2019, formatted in XBRL (eXtensible Business Reporting Language): (i) Condensed Consolidated Balance Sheets (unaudited) as of March 31, 2019 and December 31, 2018, (ii) Condensed Consolidated Statements of Operations (unaudited) for the Three Months Ended March 31, 2019 and 2018, (iii) Condensed Consolidated Statements of Comprehensive Loss (unaudited) for the Three Months Ended March 31, 2019 and 2018, (iv) Condensed Consolidated Statements of Convertible Preferred Stock, Redeemable Common Stock and Stockholders' Equity (Deficit) (unaudited) for the Three Months Ended March 31, 2019 and 2018, and (v) Condensed Consolidated Statements of Cash Flows (unaudited) for the Three Months Ended March 31, 2019 and 2018.	X			

* Management contract or compensatory plans or arrangements.

± Certain confidential portions of this Exhibit were omitted by means of marking such portions with brackets ("[***]") because the identified confidential portions (i) are not material and (ii) would be competitively harmful if publicly disclosed.

X4 PHARMACEUTICALS, INC.

SIGNATURES

Pursuant to the requirements of the Securities Exchange Act of 1934, the Registrant has duly caused this report to be signed on its behalf by the undersigned thereunto duly authorized.

X4 PHARMACEUTICALS, INC.

Date: May 15, 2019

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

Date: May 15, 2019

By: /s/ Adam S. Mostafa
Adam S. Mostafa
Chief Financial Officer and Treasurer

Exhibit 4.5

THIS WARRANT, AND THE SECURITIES ISSUABLE UPON THE EXERCISE OF THIS WARRANT, HAVE NOT BEEN REGISTERED UNDER THE SECURITIES ACT OF 1933, AS AMENDED (THE "ACT"), OR ANY STATE SECURITIES LAWS. THEY MAY NOT BE SOLD, OFFERED FOR SALE, PLEDGED, OR HYPOTHECATED IN THE ABSENCE OF AN EFFECTIVE REGISTRATION STATEMENT RELATED THERETO OR AN OPINION OF COUNSEL (WHICH MAY BE COMPANY COUNSEL) REASONABLY SATISFACTORY TO THE COMPANY THAT SUCH REGISTRATION IS NOT REQUIRED UNDER THE ACT, OR ANY APPLICABLE STATE SECURITIES LAWS.

AMENDED AND RESTATED

WARRANT AGREEMENT

To Purchase Shares of Common Stock of

X4 PHARMACEUTICALS, INC.

Dated as of March 29, 2019 (the "Effective Date")

WHEREAS, X4 Therapeutics, Inc., formerly known as X4 Pharmaceuticals, Inc., a Delaware corporation (the "X4 Therapeutics") previously entered into a Loan and Security Agreement, dated October 19, 2018 (as amended, the "Loan Agreement") with Hercules Capital, Inc., a Maryland corporation, in its capacity as administrative and collateral agent, and Hercules Capital, Inc. (the "Warrantholder") and the other lender parties thereto;

WHEREAS, X4 Therapeutics is a wholly owned subsidiary of X4 Pharmaceuticals, Inc., a Delaware corporation, formerly known as Arsanis, Inc.;

WHERAS, on October 19, 2018, X4 Therapeutics issued to Warrantholder a warrant to purchase shares of X4 Therapeutics valued at $396,000 (as modified, the "Original Tranche 1 Warrant");

WHEREAS, pursuant to a Warrant Modification Agreement dated as of December 11, 2018, the Original Tranche 1 Warrant was modified to exercisable for shares of Arsanis Common Stock, as defined, therein.

WHEREAS, the parties desire to amend and restate the Original Warrant;

NOW, THEREFORE, in consideration of the mutual covenants and agreements contained herein, the Company (as defined below) and the Warrantholder hereby amend and restate the Original Tranche 1 Warrant and agree as follows:

SECTION 1. GRANT OF THE RIGHT TO PURCHASE COMMON STOCK.

For value received, the Company hereby grants to the Warrantholder, and the Warrantholder is entitled, upon the terms and subject to the conditions hereinafter set forth, to subscribe for and purchase, from the Company, an aggregate number of fully paid and non-assessable shares of the Common Stock equal to the quotient derived by dividing (a) the Warrant Coverage (as defined below) by (b) the Exercise Price (defined below). The Exercise Price of such shares is subject to adjustment as provided in Section 8. As used herein, the following terms shall have the following meanings:

"Act" means the Securities Act of 1933, as amended.

"Charter" means the Company's Articles of Incorporation, Certificate of Incorporation or other constitutional document, as may be amended from time to time.

"Common Stock" means the Company's common stock, $0.001 par value per share;

"Company" means X4 Pharmaceuticals, Inc., formerly known as Arsanis, Inc., a Delaware corporation, and any successor or surviving entity that assumes the obligations of the Company under this Agreement pursuant to Section 8(a).

"Exercise Price" means $19.80 per share, subject to adjustment pursuant to Section 8;

"Merger Event" means (i) any sale, lease, exclusive license or other transfer of all or substantially all assets of the Company; (ii)any merger or consolidation involving the Company in which the Company is not the surviving entity, or in which the outstanding shares of the Company's capital stock are otherwise converted into or exchanged for shares of capital stock, other securities or property of another entity; or (iii) any sale by holders of the outstanding voting equity securities of the Company in a single transaction or series of related transactions of shares constituting a majority of the outstanding combined voting power of the Company;

"Purchase Price" means, with respect to any exercise of this Agreement, an amount equal to the Exercise Price as of the relevant time multiplied by the number of shares of Common Stock requested to be exercised under this Agreement pursuant to such exercise;

"SEC" means the United States Securities and Exchange Commission; and

"Warrant Coverage" means $396,000.

SECTION 2. TERM OF THE AGREEMENT.

Except as otherwise provided for herein, the term of this Agreement and the right to purchase Common Stock as granted herein (the "Warrant") shall commence on the Effective Date and shall be exercisable for a period ending upon the earlier to occur of (i) October 19, 2028 or (ii) termination pursuant to the terms hereunder.

SECTION 3. EXERCISE OF THE PURCHASE RIGHTS.

(a) Exercise. The purchase rights set forth in this Agreement are exercisable by the Warrantholder, in whole or in part, at any time, or from time to time, prior to the expiration of the term set forth in Section 2, by tendering to the Company at its principal office a notice of exercise in the form attached hereto as Exhibit I (the "Notice of Exercise"), duly completed and executed. Promptly upon receipt of the Notice of Exercise and the payment of the Purchase Price in accordance with the terms set forth below, and in no event later than three (3) days thereafter, the Company or its transfer agent shall either (i) issue to the Warrantholder a certificate for the number of shares of Common Stock purchased or (ii) credit the same via book entry to the Warrantholder, and the Company shall execute the acknowledgment of exercise in the form attached hereto as Exhibit II (the "Acknowledgment of Exercise") indicating the number of shares which remain subject to future purchases, if any.

The Purchase Price may be paid at the Warrantholder's election either (i) by cash or check, or (ii) by surrender of all or a portion of the Warrant for shares of Common Stock to be exercised under this Agreement and, if applicable, an amended Agreement representing the remaining number of shares purchasable hereunder, as determined below ("Net Issuance"). If the Warrantholder elects the Net Issuance method, the Company will issue Common Stock in accordance with the following formula:

$$X = \frac{Y(A-B)}{A}$$

Where: X = the number of shares of Common Stock to be issued to the Warrantholder.

Y = the number of shares of Common Stock requested to be exercised under this Agreement.

A = the fair market value of one (1) share of Common Stock at the time of exercise of such shares of Common Stock.

B = the then effective Exercise Price.

For purposes of the above calculation, current fair market value of Common Stock shall mean with respect to each share of Common Stock:

(i) Reserved.

(ii)

(A) if the Common Stock is traded on a securities exchange, the fair market value shall be deemed to be the prior day closing price before the day the current fair market value of the securities is being determined; or

(B) if the Common Stock is traded over-the-counter, the fair market value shall be deemed to be the prior day closing bid and asked price quoted on the Nasdaq system (or similar system) before the day the current fair market value of the securities is being determined;

(iii) if at any time the Common Stock is not listed on any securities exchange or quoted in the Nasdaq National Market or the over-the-counter market, the current fair market value of Common Stock shall be the highest price per share which the Company could obtain from a willing buyer (not a current employee or director) for shares of Common Stock sold by the Company, from authorized but unissued shares, as determined in good faith by its Board of Directors, unless the Company shall become subject to a Merger Event, in which case the fair market value of Common Stock shall be deemed to be the per share value received by the holders of the Company's Common Stock on a common equivalent basis pursuant to such Merger Event.

Upon partial exercise by either cash or Net Issuance, the Company shall promptly issue an amended warrant agreement representing the remaining number of shares purchasable hereunder. All other terms and conditions of such amended Agreement shall be identical to those contained herein, including, but not limited to the Effective Date hereof.

(b) Exercise Prior to Expiration. To the extent this Agreement is not previously exercised as to all shares of Common Stock subject hereto, and if the then current fair market value of one share of the Common Stock is greater than the Exercise Price then in effect, this Agreement shall be deemed automatically exercised pursuant to Section 3(a) (even if not surrendered) immediately before its expiration. For purposes of such automatic exercise, the fair market value of one share of the Common Stock upon such expiration shall be determined pursuant to Section 3(a). To the extent this Agreement or any portion thereof is deemed automatically exercised pursuant to this Section 3(b), the Company agrees to promptly notify the Warrantholder of the number of shares of Common Stock, if any, the Warrantholder is to receive by reason of such automatic exercise, and to issue or cause its transfer agent to issue a certificate or a book entry credit to the Warrantholder evidencing such shares.

SECTION 4. RESERVATION OF SHARES.

During the term of this Agreement, the Company will at all times have authorized and reserved a sufficient number of shares of its Common Stock to provide for the exercise of the rights to purchase Common Stock as provided for herein. If at any time during the term hereof the number of authorized but unissued shares of Common Stock shall not be sufficient to permit exercise of this Warrant in full, the Company will use its commercially reasonable efforts to take such corporate action as may, in the opinion of its counsel, be necessary to increase its authorized but unissued shares of Common Stock to such number of shares as shall be sufficient for such purposes.

SECTION 5. NO FRACTIONAL SHARES OR SCRIP.

No fractional shares or scrip representing fractional shares shall be issued upon the exercise of this Agreement, but in lieu of such fractional shares the Company shall make a cash payment therefor upon the basis of the then fair market value of one share of Common Stock.

SECTION 6. NO RIGHTS AS SHAREHOLDER/STOCKHOLDER.

This Agreement does not entitle the Warrantholder to any voting rights or other rights as a shareholder/stockholder of the Company prior to the exercise of this Agreement.

SECTION 7. WARRANTHOLDER REGISTRY.

The Company shall maintain a registry showing the name and address of the registered holder of this Agreement. The Warrantholder's initial address, for purposes of such registry, is set forth in Section 12(g). The Warrantholder may change such address by giving written notice of such changed address to the Company.

SECTION 8. ADJUSTMENT RIGHTS.

The Exercise Price and the number of shares of Common Stock purchasable hereunder are subject to adjustment, as follows:

(a) Merger Event. If at any time there shall be a Merger Event, this Warrant shall, on and after the closing thereof, automatically and without further action on the part of any party or other person, represent the right to receive the consideration (including, without limitation, cash, securities or other property (collectively, "Reference Property")) payable on or in respect of all shares of Common Stock that are issuable hereunder as of immediately prior to the closing of such Merger Event less the Purchase Price for all such shares of Common Stock, and such Merger Event consideration shall be paid to Warrantholder as and when it is paid to the holders of the outstanding shares of Common Stock and this Warrant shall thereupon automatically terminate. Appropriate adjustment (as determined in good faith by the Company's Board of Directors and reasonably acceptable to the Warrantholder) shall be made in the application of the provisions of this Agreement with respect to the rights and interests of the Warrantholder after the Merger Event to the end that the provisions of this Agreement (including adjustments of the Exercise Price, and adjustments to ensure that the provisions of this Section 8 shall thereafter be applicable, as nearly as possible, to the purchase rights under this Agreement in relation to any Reference Property thereafter acquirable upon exercise of such purchase rights) shall continue to be applicable in their entirety, and to the greatest extent possible. To the extent this Warrant or any portion thereof is deemed automatically exercised pursuant to this Section 8(a), the Company agrees to promptly notify the Warrantholder of the Reference Property, if any, the Warrantholder is to receive by reason of such automatic exercise. Notwithstanding anything to the contrary in this Warrant, if the aggregate fair market value of the Reference Property payable under this Section 8(a) is less than the aggregate Exercise Price of this Warrant, then this Warrant shall automatically terminate immediately prior to the closing of such Merger Event without and Reference Property or other consideration being paid to the Warrantholder.

(b) Reclassification of Shares. Except for Merger Events subject to Sections 8(a), if the Company at any time shall, by combination, reclassification, exchange or subdivision of securities or otherwise, change any of the securities as to which purchase rights under this Agreement exist into the same or a different number of securities of any other class or classes, this Agreement shall thereafter represent the right to acquire such number and kind of securities as would have been issuable as the result of such change with respect to the securities which were subject to the purchase rights under this Agreement immediately prior to such combination, reclassification, exchange, subdivision or other change. The provisions of this Section 8(b) shall similarly apply to any successive combination, reclassification, exchange, subdivision or other change.

(c) Subdivision or Combination of Shares. If the Company at any time shall combine or subdivide its Common Stock, (i) in the case of a subdivision, the Exercise Price shall be proportionately decreased and the number of shares of Common Stock issuable hereunder shall be proportionately increased, or (ii) in the case of a combination, the Exercise Price shall be proportionately increased and the number of shares of Common Stock issuable hereunder shall be proportionately decreased.

(d) Dividends. If the Company at any time while this Agreement is outstanding and unexpired shall:

(i) pay a dividend with respect to the Common Stock payable in Common Stock, then the Exercise Price shall be adjusted, from and after the date of determination of stockholders entitled to receive such dividend or distribution, to that price determined by multiplying the Exercise Price in effect immediately prior to such date of

determination by a fraction (A) the numerator of which shall be the total number of shares of Common Stock outstanding immediately prior to such dividend or distribution, and (B) the denominator of which shall be the total number of shares of Common Stock outstanding immediately after such dividend or distribution; or

(ii) make any other dividend or distribution with respect to Common Stock, except any dividend or distribution specifically provided for in any other clause of this Section 8, then, in each such case, provision shall be made by the Company such that the Warrantholder shall receive upon exercise or conversion of this Warrant a proportionate share of any such dividend or distribution as though it were the holder of the Common Stock as of the record date fixed for the determination of the stockholders of the Company entitled to receive such dividend or distribution.

(e) Notice of Adjustments. If: (i) the Company shall declare any dividend or distribution upon its stock, whether in stock, cash, property or other securities; (ii) there shall be any Merger Event; or (iii) there shall be any voluntary dissolution, liquidation or winding up of the Company; then, in connection with each such event, the Company shall send to the Warrantholder: (A) at least thirty (30) days' prior written notice of the date on which the books of the Company shall close or a record shall be taken for such dividend, distribution, subscription rights (specifying the date on which the holders of Common Stock shall be entitled thereto) or for determining rights to vote in respect of such Merger Event, dissolution, liquidation or winding up; and (B) in the case of any such Merger Event, dissolution, liquidation or winding up, at least thirty (30) days' prior written notice of the date when the same shall take place (and specifying the date on which the holders of Common Stock shall be entitled to exchange their Common Stock for securities or other property deliverable upon such Merger Event, dissolution, liquidation or winding up).

Each such written notice shall set forth, in reasonable detail, (i) the event requiring the notice, and (ii) if any adjustment is required to be made, (A) the amount of such adjustment, (B) the method by which such adjustment was calculated, (C) the adjusted Exercise Price (if the Exercise Price has been adjusted), and (D) the number of shares subject to purchase hereunder after giving effect to such adjustment, and shall be given in accordance with Section 12(g).

(f) Timely Notice. Failure to timely provide such notice required by Section 8(f) above shall entitle the Warrantholder to retain the benefit of the applicable notice period notwithstanding anything to the contrary contained in any insufficient notice received by the Warrantholder. For purposes of this Section 8(e), and notwithstanding anything to the contrary in Section 12(g), the notice period shall begin on the date the Warrantholder actually receives a written notice containing all the information required to be provided in such Section 12(g).

SECTION 9. REPRESENTATIONS, WARRANTIES AND COVENANTS OF THE COMPANY.

(a) Reservation of Common Stock. The Common Stock issuable upon exercise of the Warrantholder's rights has been duly and validly reserved and, when issued in accordance with the provisions of this Agreement, will be validly issued, fully paid and non-assessable, and will be free of any taxes, liens, charges or encumbrances of any nature whatsoever; provided, that the Common Stock issuable pursuant to this Agreement may be subject to restrictions on transfer under state and/or federal securities laws. The Company has made available to the Warrantholder true, correct and complete copies of its Charter and current bylaws. The issuance of certificates for shares of Common Stock upon exercise of this Agreement shall be made without charge to the Warrantholder for any issuance tax in respect thereof, or other cost incurred by the Company in connection with such exercise and the related issuance of shares of Common Stock; provided, that the Company shall not be required to pay any tax which may be payable in respect of any transfer and the issuance and delivery of any certificate in a name other than that of the Warrantholder.

(b) Due Authority. The execution and delivery by the Company of this Agreement and the performance of all obligations of the Company hereunder, including the issuance to the Warrantholder of the right to acquire the shares of Common Stock have been duly authorized by all necessary corporate action on the part of the Company. This Agreement: (i) does not violate the Charter or the Company's current bylaws; (ii) does not contravene any law or governmental rule, regulation or order applicable to the Company; and (iii) does not and will not contravene any provision of, or constitute a default under, any indenture, mortgage, contract or other instrument to which the Company is a party or by which it is bound. This Agreement constitutes a legal, valid and binding agreement of the Company, enforceable in accordance with its terms.

(c) Consents and Approvals. No consent or approval of, giving of notice to, registration with, or taking of any other action in respect of any state, federal or other governmental authority or agency is required with respect to the execution, delivery and performance by the Company of its obligations under this Agreement, except for the filing of notices pursuant to Regulation D under the Act and any filing required by applicable state securities law, which filings will be effective by the time required thereby.

(d) Exempt Transaction. Subject to the accuracy of the Warrantholder's representations in Section 10, the issuance of the Common Stock upon exercise of this Agreement will constitute a transaction exempt from (i) the registration requirements of Section 5 of the Act, in reliance upon Section 4(2) thereof, and (ii) the qualification requirements of the applicable state securities laws.

(e) Compliance with Rule 144. The Company shall, at all times prior to the earlier to occur of (i) the date of sale or other disposition by Warrantholder of this Warrant or all shares of Common Stock issued on exercise of this Warrant, or (ii) the expiration or earlier termination of this Warrant if the Warrant has not been exercised in full or in part on such date, use all commercially reasonable efforts to timely file all reports required under the Exchange Act and otherwise timely take all actions necessary to permit the Warrantholder to sell or otherwise dispose of this Warrant and the shares of Common Stock issued on exercise hereof pursuant to Rule 144 promulgated under the Act ("Rule 144"), provided that the foregoing shall not apply in the event of a Merger Event following which the successor or surviving entity is not subject to the reporting requirements of the Exchange Act. If the Warrantholder proposes to sell Common Stock issuable upon the exercise of this Agreement in compliance with Rule 144 promulgated by the SEC, then, upon the Warrantholder's written request to the Company, the Company shall furnish to the Warrantholder, within ten days after receipt of such request, a written statement confirming the Company's compliance with the filing requirements of the SEC as set forth in such Rule, as such Rule may be amended from time to time.

SECTION 10. REPRESENTATIONS AND COVENANTS OF THE WARRANTHOLDER.

This Agreement has been entered into by the Company in reliance upon the following representations and covenants of the Warrantholder:

(a) Investment Purpose. The right to acquire Common Stock is being acquired for investment and not with a view to the sale or distribution of any part thereof, and the Warrantholder has no present intention of selling or engaging in any public distribution of such rights or the Common Stock except pursuant to an effective registration statement or an exemption from the registration requirements of the Act.

(b) Private Issue. The Warrantholder understands (i) that the Common Stock issuable upon exercise of this Agreement is not registered under the Act or qualified under applicable state securities laws on the ground that the issuance contemplated by this Agreement will be exempt from the registration and qualifications requirements thereof, and (ii) that the Company's reliance on such exemption is predicated on the representations set forth in this Section 10.

(c) Financial Risk. The Warrantholder has such knowledge and experience in financial and business matters as to be capable of evaluating the merits and risks of its investment, and has the ability to bear the economic risks of its investment.

(d) Accredited Investor. The Warrantholder is an "accredited investor" within the meaning of the Securities and Exchange Rule 501 of Regulation D, as presently in effect.

SECTION 11. TRANSFERS.

Subject to compliance with applicable federal and state securities laws, this Agreement and all rights hereunder are transferable, in whole or in part, without charge to the holder hereof (except for transfer taxes) upon surrender of this Agreement properly endorsed. Each taker and holder of this Agreement, by taking or holding the same, consents and agrees that this Agreement, when endorsed in blank, shall be deemed negotiable, and that the holder hereof, when this Agreement shall have been so endorsed and its transfer recorded on the Company's books, shall be treated by the Company and all other persons dealing with this Agreement as the absolute owner hereof for any purpose and as the person entitled to exercise the rights represented by this Agreement. The transfer of this Agreement shall be recorded on the books of the Company upon receipt by the Company of a notice of transfer in the form attached hereto as Exhibit III (the "Transfer Notice"), at its principal offices and the payment to the Company of all transfer taxes and other governmental charges imposed on such transfer. Until the Company receives such Transfer Notice, the Company may treat the registered owner hereof as the owner for all purposes. Notwithstanding anything herein to the contrary, the Company shall not require an opinion of counsel in connection with any sale, assignment or other transfer by the Warrantholder of this Warrant (or any portion hereof or any interest herein) or of any shares of Common Stock issued upon any exercise hereof to an affiliate (as defined in Regulation D) of the Warrantholder, provided that such affiliate is an "accredited investor" as defined in Regulation D.

SECTION 12. MISCELLANEOUS.

(a) Effective Date. The provisions of this Agreement shall be construed and shall be given effect in all respects as if it had been executed and delivered by the Company on the date hereof. This Agreement shall be binding upon any successors or assigns of the Company.

(b) Remedies. In the event of any default hereunder, the non-defaulting party may proceed to protect and enforce its rights either by suit in equity and/or by action at law, including but not limited to an action for damages as a result of any such default, and/or an action for specific performance for any default where the Warrantholder will not have an adequate remedy at law and where damages will not be readily ascertainable. The Company expressly agrees that it shall not oppose an application by the Warrantholder or any other person entitled to the benefit of this Agreement requiring specific performance of any or all provisions hereof or enjoining the Company from continuing to commit any such breach of this Agreement.

(c) No Impairment of Rights. The Company will not, by amendment of its Charter or through any other means, avoid or seek to avoid the observance or performance of any of the terms of this Agreement, but will at all times in good faith assist in the carrying out of all such terms and in the taking of all such actions as may be necessary or appropriate in order to protect the rights of the Warrantholder against impairment.

(d) Additional Documents. The Company shall supply documentation reasonably necessary to evaluate whether to exercise this Warrant, including without limitation, (i) any merger/purchase/asset sale agreement and related documents and estimated payout allocations to each of the respective shareholders, warrant and option holders in connection with a Merger Event, (ii) the most recent capitalization tables, and (iii) the most recent Charter, in the case of information provided pursuant to clauses (i) and (ii) above, subject to the Warrantholder having confidentiality obligations with respect thereto reasonably acceptable to the Company.

(e) Attorney's Fees. In any litigation, arbitration or court proceeding between the Company and the Warrantholder relating hereto, the prevailing party shall be entitled to attorneys' fees and expenses and all costs of proceedings incurred in enforcing this Agreement. For the purposes of this Section 12(e), attorneys' fees shall include without limitation fees incurred in connection with the following: (i) contempt proceedings; (ii) discovery; (iii) any motion, proceeding or other activity of any kind in connection with an insolvency proceeding; (iv) garnishment, levy, and debtor and third party examinations; and (v) post-judgment motions and proceedings of any kind, including without limitation any activity taken to collect or enforce any judgment.

(f) Severability. In the event any one or more of the provisions of this Agreement shall for any reason be held invalid, illegal or unenforceable, the remaining provisions of this Agreement shall be unimpaired, and the invalid, illegal or unenforceable provision shall be replaced by a mutually acceptable valid, legal and enforceable provision, which comes closest to the intention of the parties underlying the invalid, illegal or unenforceable provision.

(g) Notices. Except as otherwise provided herein, any notice, demand, request, consent, approval, declaration, service of process or other communication that is required, contemplated, or permitted under this Agreement or with respect to the subject matter hereof shall be in writing, and shall be deemed to have been validly served, given, delivered, and received upon the earlier of: (i) the day of transmission by facsimile or hand delivery if transmission or delivery occurs on a business day at or before 5:00 pm in the time zone of the recipient, or, if transmission or delivery occurs on a non-business day or after such time, the first business day thereafter, or the first business day after deposit with an overnight express service or overnight mail delivery service; or (ii) the third (3rd) calendar day after deposit in the United States mails, with proper first class postage prepaid, and shall be addressed to the party to be notified as follows:

If to the Warrantholder:

HERCULES CAPITAL, INC.
Legal Department
Attention: Chief Legal Officer and Bryan Jadot
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301
Email: legal@herculestech.com; bjadot@htgc.com
Telephone: 650-289-3060

(i) If to the Company:

X4 Pharmaceuticals, Inc.
Attention: Adam Mostafa and Brian Bowersox
955 Massachusetts Avenue, 4th Floor
Boston, MA 02139
Email: adam.mostafa@x4pharma.com and brian.bowersox@x4pharma.com
Telephone: 617-542-6000

or to such other address as each party may designate for itself by like notice.

(h) Entire Agreement; Amendments. This Agreement constitutes the entire agreement and understanding of the parties hereto in respect of the subject matter hereof, and supersedes and replaces in their entirety any prior proposals, term sheets, letters, negotiations or other documents or agreements, whether written or oral, with respect to the subject matter hereof (including the Warrantholder's proposal letter dated September 13, 2018 and the Original Tranche 1 Warrant). None of the terms of this Agreement may be amended except by an instrument executed by each of the parties hereto.

(i) Headings. The various headings in this Agreement are inserted for convenience only and shall not affect the meaning or interpretation of this Agreement or any provisions hereof.

(j) No Strict Construction. The parties hereto have participated jointly in the negotiation and drafting of this Agreement. In the event an ambiguity or question of intent or interpretation arises, this Agreement shall be construed as if drafted jointly by the parties hereto and no presumption or burden of proof shall arise favoring or disfavoring any party by virtue of the authorship of any provisions of this Agreement.

(k) No Waiver. No omission or delay by the Warrantholder at any time to enforce any right or remedy reserved to it, or to require performance of any of the terms, covenants or provisions hereof by the Company at any time designated, shall be a waiver of any such right or remedy to which the Warrantholder is entitled, nor shall it in any way affect the right of the Warrantholder to enforce such provisions thereafter.

(l) Survival. All agreements, representations and warranties contained in this Agreement or in any document delivered pursuant hereto shall be for the benefit of the Warrantholder and shall survive the execution and delivery of this Agreement and the expiration or other termination of this Agreement.

(m) Governing Law. This Agreement has been negotiated and delivered to Warrantholder in the State of California, and shall have been accepted by the Warrantholder in the State of California. Delivery of Common Stock to the Warrantholder by the Company under this Agreement is due in the State of California. This Agreement shall be governed by, and construed and enforced in accordance with, the laws of the State of Delaware, excluding conflict of laws principles that would cause the application of laws of any other jurisdiction.

(n) Consent to Jurisdiction and Venue. All judicial proceedings arising in or under or related to this Agreement may be brought in any state or federal court of competent jurisdiction located in the State of California. By execution and delivery of this Agreement, each party hereto generally and unconditionally: (i) consents to personal jurisdiction in Santa Clara County, State of California; (ii) waives any objection as to jurisdiction or venue in Santa Clara County, State of California; (c) agrees not to assert any defense based on lack of jurisdiction or venue in the aforesaid courts; and (iii) irrevocably agrees to be bound by any judgment rendered thereby in connection with this Agreement. Service of process on any party hereto in any action arising out of or relating to this Agreement shall be effective if given in accordance with the requirements for notice set forth in Section 12(g), and shall be deemed effective and received as set forth in Section 12(g). Nothing herein shall affect the right to serve process in any other manner permitted by law or shall limit the right of either party to bring proceedings in the courts of any other jurisdiction.

(o) Mutual Waiver of Jury Trial. Because disputes arising in connection with complex financial transactions are most quickly and economically resolved by an experienced and expert person and the parties wish applicable state and federal laws to apply (rather than arbitration rules), the parties desire that their disputes be resolved by a judge applying such applicable laws. EACH OF THE COMPANY AND THE WARRANTHOLDER SPECIFICALLY WAIVES ANY RIGHT IT MAY HAVE TO TRIAL BY JURY OF ANY CAUSE OF ACTION, CLAIM, CROSS-CLAIM, COUNTERCLAIM, THIRD PARTY CLAIM OR ANY OTHER CLAIM (COLLECTIVELY, "CLAIMS") ASSERTED BY THE COMPANY AGAINST THE WARRANTHOLDER OR ITS ASSIGNEE OR BY THE WARRANTHOLDER OR ITS ASSIGNEE AGAINST THE COMPANY. This waiver extends to all such Claims, including Claims that involve Persons other than the Company and the Warrantholder; Claims that arise out of or are in any way connected to the relationship between the Company and the Warrantholder; and any Claims for damages, breach of contract, specific performance, or any equitable or legal relief of any kind, arising out of this Agreement.

(p) Judicial Reference. If the waiver of jury trial set forth above is ineffective or unenforceable, the parties agree that all Claims shall be resolved by reference to a private judge sitting without a jury, pursuant to Code of Civil Procedure Section 638, before a mutually acceptable referee or, if the parties cannot agree, a referee selected by the Presiding Judge of Santa Clara County, California. Such proceeding shall be conducted in Santa Clara County, California, with Delaware rules of evidence and discovery applicable to such proceeding.

(q) Prejudgment Relief. In the event Claims are to be resolved by arbitration, either party may seek from a court of competent jurisdiction identified in Section 12(n), any prejudgment order, writ or other relief and have such prejudgment order, writ or other relief enforced to the fullest extent permitted by law notwithstanding that all Claims are otherwise subject to resolution by judicial reference.

(r) Counterparts. This Agreement and any amendments, waivers, consents or supplements hereto may be executed in any number of counterparts, and by different parties hereto in separate counterparts, each of which when so delivered shall be deemed an original, but all of which counterparts shall constitute but one and the same instrument.

[Remainder of Page Intentionally Left Blank]

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed by its officers thereunto duly authorized as of the Effective Date.

COMPANY: X4 PHARMACEUTICALS, INC.

By: /s/ Adam Mostafa
Name: Adam Mostafa
Title: Chief Financial Officer

WARRANTHOLDER: HERCULES CAPITAL, INC.

By: /s/ Jennifer Choe
Name: Jennifer Choe
Title: Assistant General Counsel

EXHIBIT I

NOTICE OF EXERCISE

To: X4 PHARMACEUTICALS, INC.

(1) The undersigned Warrantholder hereby elects to purchase [_____] shares of the Common Stock of X4 Pharmaceuticals, Inc., pursuant to the terms of the Warrant Agreement, dated as of March 29, 2019 (the "Agreement") between X4 Pharmaceuticals, Inc. and the Warrantholder, and [CASH PAYMENT: tenders herewith payment of the Purchase Price in full, together with all applicable transfer taxes, if any.] [NET ISSUANCE: elects pursuant to Section 3(a) of the Agreement to effect a Net Issuance.]

(2) Please issue a certificate or certificates representing said shares of Common Stock in the name of the undersigned or in such other name as is specified below.

_____
(Name)

_____
(Address)

WARRANTHOLDER:

HERCULES CAPITAL, INC.

By: _____
Name: _____
Title: _____
Date: _____

EXHIBIT II

ACKNOWLEDGMENT OF EXERCISE

The undersigned [ ], hereby acknowledges receipt of the "Notice of Exercise" from Hercules Capital, Inc., to purchase [ ] shares of the Common Stock of X4 Pharmaceuticals, Inc., pursuant to the terms of the Warrant Agreement by and between X4 Pharmaceuticals, Inc. and Hercules Capital, Inc. dated as of March 29, 2019 (the "Agreement"), and further acknowledges that [ ] shares remain subject to purchase under the terms of the Agreement.

COMPANY: X4 PHARMACEUTICALS, INC.

By: _____

Title: _____

Date: _____

EXHIBIT III

TRANSFER NOTICE

(To transfer or assign the foregoing Agreement execute this form and supply required information. Do not use this form to purchase shares.)

FOR VALUE RECEIVED, the foregoing Agreement and all rights evidenced thereby are hereby transferred and assigned to

_____

(Please Print)

whose address is_____

_____

Dated: _____

Holder's Signature: _____

Holder's Address: _____

_____

Signature Guaranteed: _____

NOTE: The signature to this Transfer Notice must correspond with the name as it appears on the face of the Agreement, without alteration or enlargement or any change whatever. Officers of corporations and those acting in a fiduciary or other representative capacity should file proper evidence of authority to assign the foregoing Agreement.

Exhibit 4.6

THIS WARRANT, AND THE SECURITIES ISSUABLE UPON THE EXERCISE OF THIS WARRANT, HAVE NOT BEEN REGISTERED UNDER THE SECURITIES ACT OF 1933, AS AMENDED (THE "ACT"), OR ANY STATE SECURITIES LAWS. THEY MAY NOT BE SOLD, OFFERED FOR SALE, PLEDGED, OR HYPOTHECATED IN THE ABSENCE OF AN EFFECTIVE REGISTRATION STATEMENT RELATED THERETO OR AN OPINION OF COUNSEL (WHICH MAY BE COMPANY COUNSEL) REASONABLY SATISFACTORY TO THE COMPANY THAT SUCH REGISTRATION IS NOT REQUIRED UNDER THE ACT, OR ANY APPLICABLE STATE SECURITIES LAWS.

WARRANT AGREEMENT

To Purchase Shares of Common Stock of

X4 PHARMACEUTICALS, INC.

Dated as of March 18, 2019 (the "Effective Date")

WHEREAS, X4 Therapeutics, Inc., formerly known as X4 Pharmaceuticals, Inc., a Delaware corporation (the "X4 Therapeutics") previously entered into a Loan and Security Agreement, dated October 19, 2018 (as amended, the "Loan Agreement") with Hercules Capital, Inc., a Maryland corporation, in its capacity as administrative and collateral agent, and Hercules Capital, Inc. (the "Warrantholder") and the other lender parties thereto;

WHEREAS, X4 Therapeutics is a wholly owned subsidiary of X4 Pharmaceuticals, Inc., a Delaware corporation, formerly known as Arsanis, Inc.;

WHEREAS, the parties desire to enter into this warrant agreement (this "Agreement") to pursuant to the terms of the Loan Agreement;

NOW, THEREFORE, in consideration of the mutual covenants and agreements contained herein, the Company (as defined below) and the Warrantholder agree as follows:

SECTION 1. GRANT OF THE RIGHT TO PURCHASE COMMON STOCK.

For value received, the Company hereby grants to the Warrantholder, and the Warrantholder is entitled, upon the terms and subject to the conditions hereinafter set forth, to subscribe for and purchase, from the Company, an aggregate number of fully paid and non-assessable shares of the Common Stock equal to the quotient derived by dividing (a) the Warrant Coverage (as defined below) by (b) the Exercise Price (defined below). The Exercise Price of such shares is subject to adjustment as provided in Section 8. As used herein, the following terms shall have the following meanings:

"Act" means the Securities Act of 1933, as amended.

"Charter" means the Company's Articles of Incorporation, Certificate of Incorporation or other constitutional document, as may be amended from time to time.

"Common Stock" means the Company's common stock, $0.001 par value per share;

"Company" means X4 Pharmaceuticals, Inc., formerly known as Arsanis, Inc., a Delaware corporation, and any successor or surviving entity that assumes the obligations of the Company under this Agreement pursuant to Section 8(a).

"Exercise Price" means $19.80 per share, subject to adjustment pursuant to Section 8;

"Merger Event" means (i) any sale, lease, exclusive license or other transfer of all or substantially all assets of the Company; (ii)any merger or consolidation involving the Company in which the Company is not the surviving entity, or in which the outstanding shares of the Company's capital stock are otherwise converted into or exchanged for shares of capital stock, other securities or property of another entity; or (iii) any sale by holders of the outstanding voting equity securities of the Company in a single transaction or series of related transactions of shares constituting a majority of the outstanding combined voting power of the Company;

"Purchase Price" means, with respect to any exercise of this Agreement, an amount equal to the Exercise Price as of the relevant time multiplied by the number of shares of Common Stock requested to be exercised under this Agreement pursuant to such exercise;

"SEC" means the United States Securities and Exchange Commission; and

"Warrant Coverage" means $99,000.

SECTION 2. TERM OF THE AGREEMENT.

Except as otherwise provided for herein, the term of this Agreement and the right to purchase Common Stock as granted herein (the "Warrant") shall commence on the Effective Date and shall be exercisable for a period ending upon the earlier to occur of (i) ten (10) years after the Effective Date or (ii) termination pursuant to the terms hereunder.

SECTION 3. EXERCISE OF THE PURCHASE RIGHTS.

(a) Exercise. The purchase rights set forth in this Agreement are exercisable by the Warrantholder, in whole or in part, at any time, or from time to time, prior to the expiration of the term set forth in Section 2, by tendering to the Company at its principal office a notice of exercise in the form attached hereto as Exhibit I (the "Notice of Exercise"), duly completed and executed. Promptly upon receipt of the Notice of Exercise and the payment of the Purchase Price in accordance with the terms set forth below, and in no event later than three (3) days thereafter, the Company or its transfer agent shall either (i) issue to the Warrantholder a certificate for the number of shares of Common Stock purchased or (ii) credit the same via book entry to the Warrantholder, and the Company shall execute the acknowledgment of exercise in the form attached hereto as Exhibit II (the "Acknowledgment of Exercise") indicating the number of shares which remain subject to future purchases, if any.

The Purchase Price may be paid at the Warrantholder's election either (i) by cash or check, or (ii) by surrender of all or a portion of the Warrant for shares of Common Stock to be exercised under this Agreement and, if applicable, an amended Agreement representing the remaining number of shares purchasable hereunder, as determined below ("Net Issuance"). If the Warrantholder elects the Net Issuance method, the Company will issue Common Stock in accordance with the following formula:

$$X = \frac{Y(A-B)}{A}$$

Where: X = the number of shares of Common Stock to be issued to the Warrantholder.

Y = the number of shares of Common Stock requested to be exercised under this Agreement.

A = the fair market value of one (1) share of Common Stock at the time of exercise of such shares of Common Stock.

B = the then effective Exercise Price.

For purposes of the above calculation, current fair market value of Common Stock shall mean with respect to each share of Common Stock:

(i) Reserved.

(ii)

(A) if the Common Stock is traded on a securities exchange, the fair market value shall be deemed to be the prior day closing price before the day the current fair market value of the securities is being determined; or

(B) if the Common Stock is traded over-the-counter, the fair market value shall be deemed to be the prior day closing bid and asked price quoted on the Nasdaq system (or similar system) before the day the current fair market value of the securities is being determined;

(iii) if at any time the Common Stock is not listed on any securities exchange or quoted in the Nasdaq National Market or the over-the-counter market, the current fair market value of Common Stock shall be the highest price per share which the Company could obtain from a willing buyer (not a current employee or director) for shares of Common Stock sold by the Company, from authorized but unissued shares, as determined in good faith by its Board of Directors, unless the Company shall become subject to a Merger Event, in which case the fair market value of Common Stock shall be deemed to be the per share value received by the holders of the Company's Common Stock on a common equivalent basis pursuant to such Merger Event.

Upon partial exercise by either cash or Net Issuance, the Company shall promptly issue an amended warrant agreement representing the remaining number of shares purchasable hereunder. All other terms and conditions of such amended Agreement shall be identical to those contained herein, including, but not limited to the Effective Date hereof.

(b) Exercise Prior to Expiration. To the extent this Agreement is not previously exercised as to all shares of Common Stock subject hereto, and if the then current fair market value of one share of the Common Stock is greater than the Exercise Price then in effect, this Agreement shall be deemed automatically exercised pursuant to Section 3(a) (even if not surrendered) immediately before its expiration. For purposes of such automatic exercise, the fair market value of one share of the Common Stock upon such expiration shall be determined pursuant to Section 3(a). To the extent this Agreement or any portion thereof is deemed automatically exercised pursuant to this Section 3(b), the Company agrees to promptly notify the Warrantholder of the number of shares of Common Stock, if any, the Warrantholder is to receive by reason of such automatic exercise, and to issue or cause its transfer agent to issue a certificate or a book entry credit to the Warrantholder evidencing such shares.

SECTION 4. RESERVATION OF SHARES.

During the term of this Agreement, the Company will at all times have authorized and reserved a sufficient number of shares of its Common Stock to provide for the exercise of the rights to purchase Common Stock as provided for herein. If at any time during the term hereof the number of authorized but unissued shares of Common Stock shall not be sufficient to permit exercise of this Warrant in full, the Company will use its commercially reasonable efforts to take such corporate action as may, in the opinion of its counsel, be necessary to increase its authorized but unissued shares of Common Stock to such number of shares as shall be sufficient for such purposes.

SECTION 5. NO FRACTIONAL SHARES OR SCRIP.

No fractional shares or scrip representing fractional shares shall be issued upon the exercise of this Agreement, but in lieu of such fractional shares the Company shall make a cash payment therefor upon the basis of the then fair market value of one share of Common Stock.

SECTION 6. NO RIGHTS AS SHAREHOLDER/STOCKHOLDER.

This Agreement does not entitle the Warrantholder to any voting rights or other rights as a shareholder/stockholder of the Company prior to the exercise of this Agreement.

SECTION 7. WARRANTHOLDER REGISTRY.

The Company shall maintain a registry showing the name and address of the registered holder of this Agreement. The Warrantholder's initial address, for purposes of such registry, is set forth in Section 12(g). The Warrantholder may change such address by giving written notice of such changed address to the Company.

SECTION 8. ADJUSTMENT RIGHTS.

The Exercise Price and the number of shares of Common Stock purchasable hereunder are subject to adjustment, as follows:

(a) Merger Event. If at any time there shall be a Merger Event, this Warrant shall, on and after the closing thereof, automatically and without further action on the part of any party or other person, represent the right to receive the consideration (including, without limitation, cash, securities or other property (collectively, "Reference Property")) payable on or in respect of all shares of Common Stock that are issuable hereunder as of immediately prior to the closing of such Merger Event less the Purchase Price for all such shares of Common Stock, and such Merger Event consideration shall be paid to Warrantholder as and when it is paid to the holders of the outstanding shares of Common Stock and this Warrant shall thereupon automatically terminate. Appropriate adjustment (as determined in good faith by the Company's Board of Directors and reasonably acceptable to the Warrantholder) shall be made in the application of the provisions of this Agreement with respect to the rights and interests of the Warrantholder after the Merger Event to the end that the provisions of this Agreement (including adjustments of the Exercise Price, and adjustments to ensure that the provisions of this Section 8 shall thereafter be applicable, as nearly as possible, to the purchase rights under this Agreement in relation to any Reference Property thereafter acquirable upon exercise of such purchase rights) shall continue to be applicable in their entirety, and to the greatest extent possible. To the extent this Warrant or any portion thereof is deemed automatically exercised pursuant to this Section 8(a), the Company agrees to promptly notify the Warrantholder of the Reference Property, if any, the Warrantholder is to receive by reason of such automatic exercise. Notwithstanding anything to the contrary in this Warrant, if the aggregate fair market value of the Reference Property payable under this Section 8(a) is less than the aggregate Exercise Price of this Warrant, then this Warrant shall automatically terminate immediately prior to the closing of such Merger Event without and Reference Property or other consideration being paid to the Warrantholder.

(b) Reclassification of Shares. Except for Merger Events subject to Sections 8(a), if the Company at any time shall, by combination, reclassification, exchange or subdivision of securities or otherwise, change any of the securities as to which purchase rights under this Agreement exist into the same or a different number of securities of any other class or classes, this Agreement shall thereafter represent the right to acquire such number and kind of securities as would have been issuable as the result of such change with respect to the securities which were subject to the purchase rights under this Agreement immediately prior to such combination, reclassification, exchange, subdivision or other change. The provisions of this Section 8(b) shall similarly apply to any successive combination, reclassification, exchange, subdivision or other change.

(c) Subdivision or Combination of Shares. If the Company at any time shall combine or subdivide its Common Stock, (i) in the case of a subdivision, the Exercise Price shall be proportionately decreased and the number of shares of Common Stock issuable hereunder shall be proportionately increased, or (ii) in the case of a combination, the Exercise Price shall be proportionately increased and the number of shares of Common Stock issuable hereunder shall be proportionately decreased.

(d) Dividends. If the Company at any time while this Agreement is outstanding and unexpired shall:

(i) pay a dividend with respect to the Common Stock payable in Common Stock, then the Exercise Price shall be adjusted, from and after the date of determination of stockholders entitled to receive such dividend or distribution, to that price determined by multiplying the Exercise Price in effect immediately prior to such date of determination by a fraction (A) the numerator of which shall be the total number of shares of Common Stock outstanding immediately prior to such dividend or distribution, and (B) the denominator of which shall be the total number of shares of Common Stock outstanding immediately after such dividend or distribution; or

(ii) make any other dividend or distribution with respect to Common Stock, except any dividend or distribution specifically provided for in any other clause of this Section 8, then, in each such case, provision shall be made by the Company such that the Warrantholder shall receive upon exercise or conversion of this Warrant a proportionate share of any such dividend or distribution as though it were the holder of the Common Stock as of the record date fixed for the determination of the stockholders of the Company entitled to receive such dividend or distribution.

(e) Notice of Adjustments. If: (i) the Company shall declare any dividend or distribution upon its stock, whether in stock, cash, property or other securities; (ii) there shall be any Merger Event; or (iii) there shall be any voluntary dissolution, liquidation or winding up of the Company; then, in connection with each such event, the Company shall send to the Warrantholder: (A) at least thirty (30) days' prior written notice of the date on which the books of the Company shall close or a record shall be taken for such dividend, distribution, subscription rights (specifying the date on which the holders of Common Stock shall be entitled thereto) or for determining rights to vote in respect of such Merger Event, dissolution, liquidation or winding up; and (B) in the case of any such Merger Event, dissolution, liquidation or winding up, at least thirty (30) days' prior written notice of the date when the same shall take place (and specifying the date on which the holders of Common Stock shall be entitled to exchange their Common Stock for securities or other property deliverable upon such Merger Event, dissolution, liquidation or winding up).

Each such written notice shall set forth, in reasonable detail, (i) the event requiring the notice, and (ii) if any adjustment is required to be made, (A) the amount of such adjustment, (B) the method by which such adjustment was calculated, (C) the adjusted Exercise Price (if the Exercise Price has been adjusted), and (D) the number of shares subject to purchase hereunder after giving effect to such adjustment, and shall be given in accordance with Section 12(g).

(f) Timely Notice. Failure to timely provide such notice required by Section 8(f) above shall entitle the Warrantholder to retain the benefit of the applicable notice period notwithstanding anything to the contrary contained in any insufficient notice received by the Warrantholder. For purposes of this Section 8(e), and notwithstanding anything to the contrary in Section 12(g), the notice period shall begin on the date the Warrantholder actually receives a written notice containing all the information required to be provided in such Section 12(g).

SECTION 9. REPRESENTATIONS, WARRANTIES AND COVENANTS OF THE COMPANY.

(a) Reservation of Common Stock. The Common Stock issuable upon exercise of the Warrantholder's rights has been duly and validly reserved and, when issued in accordance with the provisions of this Agreement, will be validly issued, fully paid and non-assessable, and will be free of any taxes, liens, charges or encumbrances of any nature whatsoever; provided, that the Common Stock issuable pursuant to this Agreement may be subject to restrictions on transfer under state and/or federal securities laws. The Company has made available to the Warrantholder true, correct and complete copies of its Charter and current bylaws. The issuance of certificates for shares of Common Stock upon exercise of this Agreement shall be made without charge to the Warrantholder for any issuance tax in respect thereof, or other cost incurred by the Company in connection with such exercise and the related issuance of shares of Common Stock; provided, that the Company shall not be required to pay any tax which may be payable in respect of any transfer and the issuance and delivery of any certificate in a name other than that of the Warrantholder.

(b) Due Authority. The execution and delivery by the Company of this Agreement and the performance of all obligations of the Company hereunder, including the issuance to the Warrantholder of the right to acquire the shares of Common Stock have been duly authorized by all necessary corporate action on the part of the Company. This Agreement: (i) does not violate the Charter or the Company's current bylaws; (ii) does not contravene any law or governmental rule, regulation or order applicable to the Company; and (iii) does not and will not contravene any provision of, or constitute a

default under, any indenture, mortgage, contract or other instrument to which the Company is a party or by which it is bound. This Agreement constitutes a legal, valid and binding agreement of the Company, enforceable in accordance with its terms.

(c) Consents and Approvals. No consent or approval of, giving of notice to, registration with, or taking of any other action in respect of any state, federal or other governmental authority or agency is required with respect to the execution, delivery and performance by the Company of its obligations under this Agreement, except for the filing of notices pursuant to Regulation D under the Act and any filing required by applicable state securities law, which filings will be effective by the time required thereby.

(d) Exempt Transaction. Subject to the accuracy of the Warrantholder's representations in Section 10, the issuance of the Common Stock upon exercise of this Agreement will constitute a transaction exempt from (i) the registration requirements of Section 5 of the Act, in reliance upon Section 4(2) thereof, and (ii) the qualification requirements of the applicable state securities laws.

(e) Compliance with Rule 144. The Company shall, at all times prior to the earlier to occur of (i) the date of sale or other disposition by Warrantholder of this Warrant or all shares of Common Stock issued on exercise of this Warrant, or (ii) the expiration or earlier termination of this Warrant if the Warrant has not been exercised in full or in part on such date, use all commercially reasonable efforts to timely file all reports required under the Exchange Act and otherwise timely take all actions necessary to permit the Warrantholder to sell or otherwise dispose of this Warrant and the shares of Common Stock issued on exercise hereof pursuant to Rule 144 promulgated under the Act ("Rule 144"), provided that the foregoing shall not apply in the event of a Merger Event following which the successor or surviving entity is not subject to the reporting requirements of the Exchange Act. If the Warrantholder proposes to sell Common Stock issuable upon the exercise of this Agreement in compliance with Rule 144 promulgated by the SEC, then, upon the Warrantholder's written request to the Company, the Company shall furnish to the Warrantholder, within ten days after receipt of such request, a written statement confirming the Company's compliance with the filing requirements of the SEC as set forth in such Rule, as such Rule may be amended from time to time.

SECTION 10. REPRESENTATIONS AND COVENANTS OF THE WARRANTHOLDER.

This Agreement has been entered into by the Company in reliance upon the following representations and covenants of the Warrantholder:

(a) Investment Purpose. The right to acquire Common Stock is being acquired for investment and not with a view to the sale or distribution of any part thereof, and the Warrantholder has no present intention of selling or engaging in any public distribution of such rights or the Common Stock except pursuant to an effective registration statement or an exemption from the registration requirements of the Act.

(b) Private Issue. The Warrantholder understands (i) that the Common Stock issuable upon exercise of this Agreement is not registered under the Act or qualified under applicable state securities laws on the ground that the issuance contemplated by this Agreement will be exempt from the registration and qualifications requirements thereof, and (ii) that the Company's reliance on such exemption is predicated on the representations set forth in this Section 10.

(c) Financial Risk. The Warrantholder has such knowledge and experience in financial and business matters as to be capable of evaluating the merits and risks of its investment, and has the ability to bear the economic risks of its investment.

(d) Accredited Investor. The Warrantholder is an "accredited investor" within the meaning of the Securities and Exchange Rule 501 of Regulation D, as presently in effect.

SECTION 11. TRANSFERS.

Subject to compliance with applicable federal and state securities laws, this Agreement and all rights hereunder are transferable, in whole or in part, without charge to the holder hereof (except for transfer taxes) upon surrender of this Agreement properly endorsed. Each taker and holder of this Agreement, by taking or holding the same, consents and agrees that this Agreement, when endorsed in blank, shall be deemed negotiable, and that the holder hereof, when this Agreement shall have been so endorsed and its transfer recorded on the Company's books, shall be treated by the Company and all other persons dealing with this Agreement as the absolute owner hereof for any purpose and as the person entitled to exercise the rights represented by this Agreement. The transfer of this Agreement shall be recorded on the books of the Company upon receipt by the Company of a notice of transfer in the form attached hereto as Exhibit III (the "Transfer Notice"), at its principal offices and the payment to the Company of all transfer taxes and other governmental charges imposed on such transfer. Until the Company receives such Transfer Notice, the Company may treat the registered owner hereof as the owner for all purposes. Notwithstanding anything herein to the contrary, the Company shall not require an opinion of counsel in connection with any sale, assignment or other transfer by the Warrantholder of this Warrant (or any portion hereof or any interest herein) or of any shares of Common Stock issued upon any exercise hereof to an affiliate (as defined in Regulation D) of the Warrantholder, provided that such affiliate is an "accredited investor" as defined in Regulation D.

SECTION 12. MISCELLANEOUS.

(a) Effective Date. The provisions of this Agreement shall be construed and shall be given effect in all respects as if it had been executed and delivered by the Company on the date hereof. This Agreement shall be binding upon any successors or assigns of the Company.

(b) Remedies. In the event of any default hereunder, the non-defaulting party may proceed to protect and enforce its rights either by suit in equity and/or by action at law, including but not limited to an action for damages as a result of any such default, and/or an action for specific performance for any default where the Warrantholder will not have an adequate remedy at law and where damages will not be readily ascertainable. The Company expressly agrees that it shall not oppose an application by the Warrantholder or any other person entitled to the benefit of this Agreement requiring specific performance of any or all provisions hereof or enjoining the Company from continuing to commit any such breach of this Agreement.

(c) No Impairment of Rights. The Company will not, by amendment of its Charter or through any other means, avoid or seek to avoid the observance or performance of any of the terms of this Agreement, but will at all times in good faith assist in the carrying out of all such terms and in the taking of all such actions as may be necessary or appropriate in order to protect the rights of the Warrantholder against impairment.

(d) Additional Documents. The Company shall supply documentation reasonably necessary to evaluate whether to exercise this Warrant, including without limitation, (i) any merger/purchase/asset sale agreement and related documents and estimated payout allocations to each of the respective shareholders, warrant and option holders in connection with a Merger Event, (ii) the most recent capitalization tables, and (iii) the most recent Charter, in the case of information provided pursuant to clauses (i) and (ii) above, subject to the Warrantholder having confidentiality obligations with respect thereto reasonably acceptable to the Company.

(e) Attorney's Fees. In any litigation, arbitration or court proceeding between the Company and the Warrantholder relating hereto, the prevailing party shall be entitled to attorneys' fees and expenses and all costs of proceedings incurred in enforcing this Agreement. For the purposes of this Section 12(e), attorneys' fees shall include without limitation fees incurred in connection with the following: (i) contempt proceedings; (ii) discovery; (iii) any motion, proceeding or other activity of any kind in connection with an insolvency proceeding; (iv) garnishment, levy, and debtor and third party examinations; and (v) post-judgment motions and proceedings of any kind, including without limitation any activity taken to collect or enforce any judgment.

(f) Severability. In the event any one or more of the provisions of this Agreement shall for any reason be held invalid, illegal or unenforceable, the remaining provisions of this Agreement shall be unimpaired, and the invalid, illegal or unenforceable provision shall be replaced by a mutually acceptable valid, legal and enforceable provision, which comes closest to the intention of the parties underlying the invalid, illegal or unenforceable provision.

(g) Notices. Except as otherwise provided herein, any notice, demand, request, consent, approval, declaration, service of process or other communication that is required, contemplated, or permitted under this Agreement or with respect to the subject matter hereof shall be in writing, and shall be deemed to have been validly served, given, delivered, and received upon the earlier of: (i) the day of transmission by facsimile or hand delivery if transmission or delivery occurs on a business day at or before 5:00 pm in the time zone of the recipient, or, if transmission or delivery occurs on a non-business day or after such time, the first business day thereafter, or the first business day after deposit with an overnight express service or overnight mail delivery service; or (ii) the third (3rd) calendar day after deposit in the United States mails, with proper first class postage prepaid, and shall be addressed to the party to be notified as follows:

If to the Warrantholder:

HERCULES CAPITAL, INC.
Legal Department
Attention: Chief Legal Officer and Bryan Jadot
400 Hamilton Avenue, Suite 310
Palo Alto, CA 94301
Email: legal@herculestech.com; bjadot@htgc.com
Telephone: 650-289-3060

(i) If to the Company:

X4 Pharmaceuticals, Inc.
Attention: Adam Mostafa and Brian Bowersox
955 Massachusetts Avenue, 4th Floor
Boston, MA 02139
Email: adam.mostafa@x4pharma.com and brian.bowersox@x4pharma.com
Telephone: 617-542-6000

or to such other address as each party may designate for itself by like notice.

(h) Entire Agreement; Amendments. This Agreement constitutes the entire agreement and understanding of the parties hereto in respect of the subject matter hereof, and supersedes and replaces in their entirety any prior proposals, term sheets, letters, negotiations or other documents or agreements, whether written or oral, with respect to the subject matter hereof (including the Warrantholder's proposal letter dated September 13, 2018). None of the terms of this Agreement may be amended except by an instrument executed by each of the parties hereto.

(i) Headings. The various headings in this Agreement are inserted for convenience only and shall not affect the meaning or interpretation of this Agreement or any provisions hereof.

(j) No Strict Construction. The parties hereto have participated jointly in the negotiation and drafting of this Agreement. In the event an ambiguity or question of intent or interpretation arises, this Agreement shall be construed as if drafted jointly by the parties hereto and no presumption or burden of proof shall arise favoring or disfavoring any party by virtue of the authorship of any provisions of this Agreement.

(k) No Waiver. No omission or delay by the Warrantholder at any time to enforce any right or remedy reserved to it, or to require performance of any of the terms, covenants or provisions hereof by the Company at any time designated, shall be a waiver of any such right or remedy to which the Warrantholder is entitled, nor shall it in any way affect the right of the Warrantholder to enforce such provisions thereafter.

(l) Survival. All agreements, representations and warranties contained in this Agreement or in any document delivered pursuant hereto shall be for the benefit of the Warrantholder and shall survive the execution and delivery of this Agreement and the expiration or other termination of this Agreement.

(m) Governing Law. This Agreement has been negotiated and delivered to Warrantholder in the State of California, and shall have been accepted by the Warrantholder in the State of California. Delivery of Common Stock to the Warrantholder by the Company under this Agreement is due in the State of California. This Agreement shall be governed by, and construed and enforced in accordance with, the laws of the State of Delaware, excluding conflict of laws principles that would cause the application of laws of any other jurisdiction.

(n) Consent to Jurisdiction and Venue. All judicial proceedings arising in or under or related to this Agreement may be brought in any state or federal court of competent jurisdiction located in the State of California. By execution and delivery of this Agreement, each party hereto generally and unconditionally: (i) consents to personal jurisdiction in Santa Clara County, State of California; (ii) waives any objection as to jurisdiction or venue in Santa Clara County, State of California; (c) agrees not to assert any defense based on lack of jurisdiction or venue in the aforesaid courts; and (iii) irrevocably agrees to be bound by any judgment rendered thereby in connection with this Agreement. Service of process on any party hereto in any action arising out of or relating to this Agreement shall be effective if given in accordance with the requirements for notice set forth in Section 12(g), and shall be deemed effective and received as set forth in Section 12(g). Nothing herein shall affect the right to serve process in any other manner permitted by law or shall limit the right of either party to bring proceedings in the courts of any other jurisdiction.

(o) Mutual Waiver of Jury Trial. Because disputes arising in connection with complex financial transactions are most quickly and economically resolved by an experienced and expert person and the parties wish applicable state and federal laws to apply (rather than arbitration rules), the parties desire that their disputes be resolved by a judge applying such applicable laws. EACH OF THE COMPANY AND THE WARRANTHOLDER SPECIFICALLY WAIVES ANY RIGHT IT MAY HAVE TO TRIAL BY JURY OF ANY CAUSE OF ACTION, CLAIM, CROSS-CLAIM, COUNTERCLAIM, THIRD PARTY CLAIM OR ANY OTHER CLAIM (COLLECTIVELY, "CLAIMS") ASSERTED BY THE COMPANY AGAINST THE WARRANTHOLDER OR ITS ASSIGNEE OR BY THE WARRANTHOLDER OR ITS ASSIGNEE AGAINST THE COMPANY. This waiver extends to all such Claims, including Claims that involve Persons other than the Company and the Warrantholder; Claims that arise out of or are in any way connected to the relationship between the Company and the Warrantholder; and any Claims for damages, breach of contract, specific performance, or any equitable or legal relief of any kind, arising out of this Agreement.

(p) Judicial Reference. If the waiver of jury trial set forth above is ineffective or unenforceable, the parties agree that all Claims shall be resolved by reference to a private judge sitting without a jury, pursuant to Code of Civil Procedure Section 638, before a mutually acceptable referee or, if the parties cannot agree, a referee selected by the Presiding Judge of Santa Clara County, California. Such proceeding shall be conducted in Santa Clara County, California, with Delaware rules of evidence and discovery applicable to such proceeding.

(q) Prejudgment Relief. In the event Claims are to be resolved by arbitration, either party may seek from a court of competent jurisdiction identified in Section 12(n), any prejudgment order, writ or other relief and have such prejudgment order, writ or other relief enforced to the fullest extent permitted by law notwithstanding that all Claims are otherwise subject to resolution by judicial reference.

(r) Counterparts. This Agreement and any amendments, waivers, consents or supplements hereto may be executed in any number of counterparts, and by different parties hereto in separate counterparts, each of which when so delivered shall be deemed an original, but all of which counterparts shall constitute but one and the same instrument.

[Remainder of Page Intentionally Left Blank]

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed by its officers thereunto duly authorized as of the Effective Date.

COMPANY: X4 PHARMACEUTICALS, INC.

By: /s/ Adam Mostafa
Name: Adam Mostafa
Title: Chief Financial Officer

WARRANTHOLDER: HERCULES CAPITAL, INC.

By: /s/ Jennifer Choe
Name: Jennifer Choe
Title: Assistant General Counsel

EXHIBIT I

NOTICE OF EXERCISE

To: X4 PHARMACEUTICALS, INC.

(1) The undersigned Warrantholder hereby elects to purchase [ ] shares of the Common Stock of X4 Pharmaceuticals, Inc., pursuant to the terms of the Warrant Agreement, dated as of March 18, 2019 (the "Agreement") between X4 Pharmaceuticals, Inc. and the Warrantholder, and [CASH PAYMENT: tenders herewith payment of the Purchase Price in full, together with all applicable transfer taxes, if any.] [NET ISSUANCE: elects pursuant to Section 3(a) of the Agreement to effect a Net Issuance.]

(2) Please issue a certificate or certificates representing said shares of Common Stock in the name of the undersigned or in such other name as is specified below.

_____
(Name)

_____
(Address)

WARRANTHOLDER:

HERCULES CAPITAL, INC.

By: _____
Name: _____
Title: _____
Date: _____

EXHIBIT II

ACKNOWLEDGMENT OF EXERCISE

The undersigned [ ], hereby acknowledges receipt of the "Notice of Exercise" from Hercules Capital, Inc., to purchase [ ] shares of the Common Stock of X4 Pharmaceuticals, Inc., pursuant to the terms of the Warrant Agreement by and between X4 Pharmaceuticals, Inc. and Hercules Capital, Inc. dated as of March 18, 2019 (the "Agreement"), and further acknowledges that [ ] shares remain subject to purchase under the terms of the Agreement.

COMPANY: X4 PHARMACEUTICALS, INC.

By: _____
Title: _____
Date: _____

EXHIBIT III

TRANSFER NOTICE

(To transfer or assign the foregoing Agreement execute this form and supply required information. Do not use this form to purchase shares.)

FOR VALUE RECEIVED, the foregoing Agreement and all rights evidenced thereby are hereby transferred and assigned to

_____

(Please Print)

whose address is_____

_____

Dated: _____

Holder's Signature: _____

Holder's Address: _____

_____

Signature Guaranteed: _____

NOTE: The signature to this Transfer Notice must correspond with the name as it appears on the face of the Agreement, without alteration or enlargement or any change whatever. Officers of corporations and those acting in a fiduciary or other representative capacity should file proper evidence of authority to assign the foregoing Agreement.

Exhibit 10.14

FORM FOR ARSANIS, INC. 2017 EQUITY INCENTIVE PLAN
(MARCH 2019)

X4 PHARMACEUTICALS, INC.

RESTRICTED STOCK AGREEMENT

X4 Pharmaceuticals, Inc. (the "Company") has selected you to receive the following restricted stock award pursuant to its 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan). The terms and conditions attached hereto are also a part hereof.

Notice of Grant

Name of recipient (the "Recipient"):	
Grant Date:	
Number of shares of the restricted common stock awarded:	
Vesting Start Date:	

Vesting Schedule:

[First Anniversary of Vesting Start Date]	[25%]
[Last day of each month following the First Anniversary of the Vesting Start Date thereafter]	[2.0833%]
All vesting is dependent on the Recipient remaining employed by the Company, as provided herein.	
[Notwithstanding the foregoing, 100% of the unvested portion of the Restricted Shares shall vest upon the termination of the Recipient's employment by the Company without Cause upon or at any time within 12 months following a Change of Control. For purposes of this Agreement, a "Change of Control" shall mean the occurrence of any of the following events: (i) any "Person" (as such term is used in Sections 13(d) and 14(d) of the Exchange Act) becomes the "Beneficial Owner" (as defined in Rule 13d-3 under the Exchange Act), directly or indirectly, of securities of the Company representing fifty percent (50%) or more of the total voting power represented by the Company's then outstanding voting securities (excluding for this purpose any such voting securities held by the Company, or any affiliate, parent or subsidiary of the Company, or by any employee benefit plan of the Company) pursuant to a transaction or a series of related transactions which the Board does not approve; or (ii) (A) A merger or consolidation of the Company whether or not approved by the Board, other than a merger or consolidation which would result in the voting securities of the Company outstanding immediately prior thereto continuing to represent (either by remaining outstanding or by being converted into voting securities of the surviving entity or the parent of such entity) at least fifty percent (50%) of the total voting power represented by the voting securities of the Company or such surviving entity or parent of such entity, as the case may be, outstanding immediately after such merger or consolidation; or (B) the sale or disposition by the Company of all or substantially all of the Company's assets. For purposes of this Agreement, if the Recipient is subject to an individual employment agreement with the Company or eligible to participate in a Company severance plan or arrangement, in any case which agreement, plan or arrangement contains a definition of "cause" for termination of employment, "Cause" shall have the meaning ascribed to such term in such agreement, plan or arrangement, otherwise, "Cause" shall mean, with respect to the Recipient (a) dishonesty with respect to the Company or any affiliate, (b) insubordination, substantial malfeasance or non-feasance of duty, (c) unauthorized disclosure of confidential information, (d) breach by the recipient of any provision of any employment, consulting, advisory, nondisclosure, non-competition or similar agreement between the Recipient and the Company or any affiliate, and (e) conduct substantially prejudicial to the business of the Company or any affiliate, with the determination of the administrator of the Plan as to the existence of Cause will be conclusive on the Recipient and the Company. The Recipient's employment shall be considered to have been terminated for Cause if the Company determines, within 30 days after the Recipient's resignation, that termination for Cause was warranted.]	

Please confirm your acceptance of this restricted stock award and of the terms and conditions of this Agreement by signing a copy of this Agreement where indicated below.

X4 PHARMACEUTICALS, INC.

By: _____
Name of Officer
Title:

Accepted and Agreed:

_____
Signature of Recipient

_____
Street Address

_____
City/State/Zip Code

X4 PHARMACEUTICALS, INC.

Restricted Stock Agreement
Incorporated Terms and Conditions

The terms and conditions of the award of shares of restricted common stock of the Company (the "Restricted Shares") made to the Recipient, as set forth in the Notice of Grant that forms part of this agreement (the "Notice of Grant"), are as follows:

1. Issuance of Restricted Shares.

(a) The Restricted Shares are issued to the Recipient, effective as of the Grant Date set forth in the Notice of Grant, in consideration of services rendered and to be rendered by the Recipient to the Company.

(b) The Restricted Shares will initially be issued by the Company in book entry form only, in the name of the Recipient. Following the vesting of any Restricted Shares pursuant to Section 2 below, the Company shall, if requested by the Recipient, issue and deliver to the Recipient a certificate representing the vested Restricted Shares. The Recipient agrees that the Restricted Shares shall be subject to the forfeiture provisions set forth in Section 3 of this Agreement and the restrictions on transfer set forth in Section 4 of this Agreement.

2. Vesting.

Unless otherwise provided in this Agreement in the Arsanis, Inc. 2017 Equity Incentive Plan (the "Plan") or in another agreement between the Recipient and the Company, the Restricted Shares shall vest in accordance with the vesting schedule set forth in the Notice of Grant. Any fractional number of Restricted Shares resulting from the application of the vesting schedule shall be rounded down to the nearest whole number of Restricted Shares.

3. Forfeiture of Unvested Restricted Shares Upon Employment Termination.

In the event that the Recipient ceases to be employed by the Company for any reason or no reason, with or without cause, all of the Restricted Shares that are unvested as of the time of such employment termination shall be forfeited immediately and automatically to the Company, without the payment of any consideration to the Recipient, effective as of such termination of employment. The Recipient shall have no further rights with respect to any Restricted Shares that are so forfeited. If the Recipient is employed by a subsidiary of the Company, any references in this Agreement to employment with the Company shall instead be deemed to refer to employment with such subsidiary.

4. Restrictions on Transfer.

Except as set forth in the Plan, the Recipient shall not sell, assign, transfer, pledge, hypothecate or otherwise dispose of, by operation of law or otherwise (collectively "transfer") any Restricted Shares, or any interest therein, until such Restricted Shares have vested. The Company shall not be required (i) to transfer on its books any of the Restricted Shares which have been transferred in violation of any of the provisions of this Agreement or the Plan or (ii) to treat as owner of such Restricted Shares or to pay dividends to any transferee to whom such Restricted Shares have been transferred in violation of any of the provisions of this Agreement or the Plan.

5. Restrictive Legends.

The book entry account reflecting the issuance of the Restricted Shares in the name of the Recipient shall bear a legend or other notation upon substantially the following terms:

"These shares of stock are subject to forfeiture provisions and restrictions on transfer set forth in a certain Restricted Stock Agreement between the corporation and the registered owner of these shares (or his or her predecessor in interest), and such Agreement is available for inspection without charge at the office of the Secretary of the corporation."

6. Rights as a Shareholder.

Except as otherwise provided in this Agreement, for so long as the Recipient is the registered owner of the Restricted Shares, the Recipient shall have all rights as a shareholder with respect to the Restricted Shares, whether vested or unvested, including, without limitation, rights to vote the Restricted Shares and act in respect of the Restricted Shares at any meeting of shareholders; provided that, as provided in the Plan, the payment of dividends on unvested Restricted Shares shall be deferred until the vesting of such shares.

7. Provisions of the Plan.

This Agreement is subject to the provisions of the Plan, a copy of which is furnished to the Recipient with this Agreement.

8. Tax Matters.

(a) Acknowledgments; Section 83(b) Election. The Recipient acknowledges that he or she is responsible for obtaining the advice of the Recipient's own tax advisors with respect to the acquisition of the Restricted Shares and the Recipient is relying solely on such advisors and not on any statements or representations of the Company or any of its agents with respect to the tax consequences relating to the Restricted Shares. The Recipient understands that the Recipient (and not the Company) shall be responsible for the Recipient's tax liability that may arise in connection with the acquisition, vesting and/or disposition of the Restricted Shares. The Recipient acknowledges that he or she has been informed of the availability of making an election under Section 83(b) of the Internal Revenue Code, as amended (a "Section 83(b) Election") with respect to the issuance of the Restricted Shares. The Recipient agrees to promptly deliver written notice to the Company in the event the Recipient makes a Section 83(b) Election with respect to the Restricted Shares.

(b) Withholding. The Recipient acknowledges and agrees that the Company has the right to deduct from payments of any kind otherwise due to the Recipient any federal, state, local or other taxes of any kind required by law to be withheld with respect to the issuance or vesting of the Restricted Shares.

9. Miscellaneous.

(a) No Right to Continued Employment. The Recipient acknowledges and agrees that, notwithstanding the fact that the vesting of the Restricted Shares is contingent upon his or her continued employment by the Company, this Agreement does not constitute an express or implied promise of continued employment or confer upon the Recipient any rights with respect to continued employment by the Company.

(b) Governing Law. This Agreement shall be construed, interpreted and enforced in accordance with the internal laws of the State of Delaware without regard to any applicable conflicts of laws provisions.

(c) Recipient's Acknowledgments. The Recipient acknowledges that he or she has read this Agreement, has received and read the Plan, and understands the terms and conditions of this Agreement and the Plan.

Exhibit 10.15

FORM FOR ARSANIS, INC. 2017 EQUITY INCENTIVE PLAN
(MARCH 2019)

X4 PHARMACEUTICALS, INC.

NON-QUALIFIED OPTION AGREEMENT (DIRECTOR GRANTS)

X4 Pharmaceuticals, Inc. (the "Company") hereby grants the following stock option pursuant to its 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan). The terms and conditions attached hereto are also a part hereof.

Notice of Grant

Name of optionee (the "Participant"):	
Grant Date:	
Number of shares of the Company's Common Stock subject to this option ("Shares"):	
Option exercise price per Share:	
Number, if any, of Shares that vest immediately on the grant date:	
Shares that are subject to vesting schedule:	
Vesting Start Date:	
Final Exercise Date:	

Vesting Schedule:

All vesting is dependent on the Participant remaining an Eligible Participant, as provided herein.	
[Notwithstanding the foregoing, 100% of the unvested portion of this option shall vest upon a Change of Control. For purposes of this option, a "Change of Control" shall mean the occurrence of any of the following events: (i) any "Person" (as such term is used in Sections 13(d) and 14(d) of the Exchange Act) becomes the "Beneficial Owner" (as defined in Rule 13d-3 under the Exchange Act), directly or indirectly, of securities of the Company representing fifty percent (50%) or more of the total voting power represented by the Company's then outstanding voting securities (excluding for this purpose any such voting securities held by the Company, or any affiliate, parent or subsidiary of the Company, or by any employee benefit plan of the Company) pursuant to a transaction or a series of related transactions which the Board does not approve; or (ii) (A) A merger or consolidation of the Company whether or not approved by the Board, other than a merger or consolidation which would result in the voting securities of the Company outstanding immediately prior thereto continuing to represent (either by remaining outstanding or by being converted into voting securities of the surviving entity or the parent of such entity) at least fifty percent (50%) of the total voting power represented by the voting securities of the Company or such surviving entity or parent of such entity, as the case may be, outstanding immediately after such merger or consolidation; or (B) the sale or disposition by the Company of all or substantially all of the Company's assets.]	

This option satisfies in full all commitments that the Company has to the Participant with respect to the issuance of stock, stock options or other equity securities.

X4 PHARMACEUTICALS, INC.

By: _____

Name of Officer
Title:

_____
Signature of Participant

_____
Street Address

_____
City/State/Zip Code

X4 PHARMACEUTICALS, INC.

Non-Qualified Option Agreement
Incorporated Terms and Conditions

1. Grant of Option.

This agreement evidences the grant by the Company, on the grant date (the "Grant Date") set forth in the Notice of Grant that forms part of this agreement (the "Notice of Grant"), to the Participant of an option to purchase, in whole or in part, on the terms provided herein and in the Arsanis, Inc. 2017 Equity Incentive Plan (the "Plan"), the number of Shares set forth in the Notice of Grant of common stock, $0.001 par value per share, of the Company ("Common Stock"), at the exercise price per Share set forth in the Notice of Grant. Unless earlier terminated, this option shall expire at 5:00 p.m., Eastern time, on the Final Exercise Date set forth in the Notice of Grant (the "Final Exercise Date").

It is intended that the option evidenced by this agreement shall not be an incentive stock option as defined in Section 422 of the Internal Revenue Code of 1986, as amended, and any regulations promulgated thereunder (the "Code"). Except as otherwise indicated by the context, the term "Participant", as used in this option, shall be deemed to include any person who acquires the right to exercise this option validly under its terms.

2. Vesting Schedule.

This option will become exercisable ("vest") in accordance with the vesting schedule set forth in the Notice of Grant.

The right of exercise shall be cumulative so that to the extent the option is not exercised in any period to the maximum extent permissible it shall continue to be exercisable, in whole or in part, with respect to all Shares for which it is vested until the earlier of the Final Exercise Date or the termination of this option under Section 3 hereof or the Plan.

3. Exercise of Option.

(a) Form of Exercise. Each election to exercise this option shall be in writing, in the form of the Stock Option Exercise Notice attached as Annex A, signed by the Participant, and received by the Company at its principal office, accompanied by this agreement, or in such other form (which may be electronic) as is approved by the Company, together with payment in full in the manner provided in the Plan. The Participant may purchase less than the number of shares covered hereby, provided that no partial exercise of this option may be for any fractional share.

(b) Continuous Relationship with the Company Required. Except as otherwise provided in this Section 3, this option may not be exercised unless the Participant, at the time he or she exercises this option, is, and has been at all times since the Grant Date, an employee, director or officer of, or consultant or advisor to, the Company or any other entity the employees, officers, directors, consultants, or advisors of which are eligible to receive option grants under the Plan (an "Eligible Participant").

(c) Termination of Relationship with the Company. If the Participant ceases to be an Eligible Participant for any reason, then, except as provided in paragraphs (d) and (e) below, the right to exercise this option shall terminate three months after such cessation (but in no event after the Final Exercise Date), provided that this option shall be exercisable only to the extent that the Participant was entitled to exercise this option on the date of such cessation.

Notwithstanding the foregoing, if the Participant, prior to the Final Exercise Date, violates the restrictive covenants (including, without limitation, the non-competition, non-solicitation, or confidentiality provisions) of any employment contract, the Non-Competition, Non-Solicitation, Confidentiality and Assignment of Inventions agreement to which the Participant is a party, if any, or any other agreement between the Participant and the Company, the right to exercise this option shall terminate immediately upon such violation.

(d) Exercise Period Upon Death or Disability. If the Participant dies or becomes disabled (within the meaning of Section 22(e)(3) of the Code) prior to the Final Exercise Date while he or she is an Eligible Participant and the Company has not terminated such relationship for "cause" as specified in paragraph (e) below, this option shall be exercisable, within the period of one year following the date of death or disability of the Participant, by the Participant (or in the case of death by an authorized transferee), provided that this option shall be exercisable only to the extent that this option was exercisable by the Participant on the date of his or her death or disability, and further provided that this option shall not be exercisable after the Final Exercise Date.

(e) Termination for Cause. If, prior to the Final Exercise Date, the Participant's employment or other relationship with the Company is terminated by the Company for Cause (as defined below), the right to exercise this option shall terminate immediately upon the effective date of such termination of employment or other relationship. If, prior to the Final Exercise Date, the Participant is given notice by the Company of the termination of his or her employment or other relationship by the Company for Cause, and the effective date of such termination is subsequent to the date of delivery of such notice, the right to exercise this option shall be suspended from the time of the delivery of such notice until the earlier of (i) such time as it is determined or otherwise agreed that the Participant's employment or other relationship shall not be terminated for Cause as provided in such notice or (ii) the effective date of such termination (in which case the right to exercise this option shall, pursuant to the preceding sentence, terminate upon the effective date of such termination). If the Participant is subject to an individual employment or other services agreement with the Company or eligible to participate in a Company severance plan or arrangement, in any case which agreement, plan or arrangement contains a definition of "cause" for termination of employment or such other relationship, "Cause" shall have the meaning ascribed to such term in such agreement, plan or arrangement. Otherwise, "Cause" shall mean, with respect to the Participant (a) dishonesty with respect to the Company or any affiliate, (b) insubordination, substantial malfeasance or non-feasance of duty, (c) unauthorized disclosure of confidential information, (d) breach by the Participant of any provision of any employment, consulting, advisory, nondisclosure, non-competition or similar agreement between the Participant and the Company or any affiliate, and (e) conduct substantially prejudicial to the business of the Company or any affiliate. The determination of the administrator of the Plan as to the existence of Cause will be conclusive on the Participant and the Company. The Participant's employment or other relationship shall be considered to have been terminated for Cause if the Company determines, within 30 days after the Participant's resignation, that termination for Cause was warranted.

4. Withholding.

No Shares will be issued pursuant to the exercise of this option unless and until the Participant pays to the Company, or makes provision satisfactory to the Company for payment of, any federal, state or local withholding taxes required by law to be withheld in respect of this option.

5. Transfer Restrictions; Clawback.

(a) This option may not be sold, assigned, transferred, pledged or otherwise encumbered by the Participant, either voluntarily or by operation of law, except by will or the laws of descent and distribution, and, during the lifetime of the Participant, this option shall be exercisable only by the Participant.

(b) In accepting this option, the Participant agrees to be bound by any clawback policy that the Company may adopt in the future.

6. Provisions of the Plan.

This option is subject to the provisions of the Plan (including the provisions relating to amendments to the Plan), a copy of which is furnished to the Participant with this option.

ANNEX A

X4 PHARMACEUTICALS, INC.

Stock Option Exercise Notice

X4 Pharmaceuticals, Inc.
955 Massachusetts Avenue, 4th Floor
Cambridge, MA 02139

Dear Sir or Madam:

I, (the "Participant"), hereby irrevocably exercise the right to purchase _____ shares of the Common Stock, $0.001 par value per share (the "Shares"), of X4 Pharmaceuticals, Inc. (the "Company") at $_____ per share pursuant to the Company's 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan) and a stock option agreement with the Company dated _____ (the "Option Agreement"). Enclosed herewith is a payment of $_____, the aggregate purchase price for the Shares. The certificate for the Shares should be registered in my name as it appears below or, if so indicated below, jointly in my name and the name of the person designated below, with right of survivorship.

Dated: _____
Signature
Print Name:

Address: _____

_____

Name and address of persons in whose name the Shares are to be jointly registered (if applicable):

_____

Exhibit 10.16

FORM FOR ARSANIS, INC. 2017 EQUITY INCENTIVE PLAN
(MARCH 2019)

X4 PHARMACEUTICALS, INC.

NON-QUALIFIED OPTION AGREEMENT

X4 Pharmaceuticals, Inc. (the "Company") hereby grants the following stock option pursuant to its 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan). The terms and conditions attached hereto are also a part hereof.

Notice of Grant

Name of optionee (the "Participant"):	
Grant Date:	
Number of shares of the Company's Common Stock subject to this option ("Shares"):	
Option exercise price per Share:	
Number, if any, of Shares that vest immediately on the grant date:	
Shares that are subject to vesting schedule:	
Vesting Start Date:	
Final Exercise Date:	

Vesting Schedule:

All vesting is dependent on the Participant remaining an Eligible Participant as provided herein.	
[Notwithstanding the foregoing, 100% of the unvested portion of this option shall vest upon the termination of the Participant's employment or other relationship with the Company by the Company without Cause upon or at any time within 12 months following a Change of Control. For purposes of this option, a "Change of Control" shall mean the occurrence of any of the following events: (i) any "Person" (as such term is used in Sections 13(d) and 14(d) of the Exchange Act) becomes the "Beneficial Owner" (as defined in Rule 13d-3 under the Exchange Act), directly or indirectly, of securities of the Company representing fifty percent (50%) or more of the total voting power represented by the Company's then outstanding voting securities (excluding for this purpose any such voting securities held by the Company, or any affiliate, parent or subsidiary of the Company, or by any employee benefit plan of the Company) pursuant to a transaction or a series of related transactions which the Board does not approve; or (ii) (A) A merger or consolidation of the Company whether or not approved by the Board, other than a merger or consolidation which would result in the voting securities of the Company outstanding immediately prior thereto continuing to represent (either by remaining outstanding or by being converted into voting securities of the surviving entity or the parent of such entity) at least fifty percent (50%) of the total voting power represented by the voting securities of the Company or such surviving entity or parent of such entity, as the case may be, outstanding immediately after such merger or consolidation; or (B) the sale or disposition by the Company of all or substantially all of the Company's assets.]	

This option satisfies in full all commitments that the Company has to the Participant with respect to the issuance of stock, stock options or other equity securities.

X4 PHARMACEUTICALS, INC.

By: _____

Signature of Participant

Name of Officer
Title:

Street Address

City/State/Zip Code

X4 PHARMACEUTICALS, INC.

Non-Qualified Option Agreement
Incorporated Terms and Conditions

1. Grant of Option.

This agreement evidences the grant by the Company, on the grant date (the "Grant Date") set forth in the Notice of Grant that forms part of this agreement (the "Notice of Grant"), to the Participant of an option to purchase, in whole or in part, on the terms provided herein and in the Arsanis, Inc. 2017 Equity Incentive Plan (the "Plan"), the number of Shares set forth in the Notice of Grant of common stock, $0.001par value per share, of the Company ("Common Stock"), at the exercise price per Share set forth in the Notice of Grant. Unless earlier terminated, this option shall expire at 5:00 p.m., Eastern time, on the Final Exercise Date set forth in the Notice of Grant (the "Final Exercise Date").

It is intended that the option evidenced by this agreement shall not be an incentive stock option as defined in Section 422 of the Internal Revenue Code of 1986, as amended, and any regulations promulgated thereunder (the "Code"). Except as otherwise indicated by the context, the term "Participant", as used in this option, shall be deemed to include any person who acquires the right to exercise this option validly under its terms.

2. Vesting Schedule.

This option will become exercisable ("vest") in accordance with the vesting schedule set forth in the Notice of Grant.

The right of exercise shall be cumulative so that to the extent the option is not exercised in any period to the maximum extent permissible it shall continue to be exercisable, in whole or in part, with respect to all Shares for which it is vested until the earlier of the Final Exercise Date or the termination of this option under Section 3 hereof or the Plan.

3. Exercise of Option.

(a) Form of Exercise. Each election to exercise this option shall be in writing, in the form of the Stock Option Exercise Notice attached as Annex A, signed by the Participant, and received by the Company at its principal office, accompanied by this agreement, or in such other form (which may be electronic) as is approved by the Company, together with payment in full in the manner provided in the Plan. The Participant may purchase less than the number of shares covered hereby, provided that no partial exercise of this option may be for any fractional share.

(b) Continuous Relationship with the Company Required. Except as otherwise provided in this Section 3, this option may not be exercised unless the Participant, at the time he or she exercises this option, is, and has been at all times since the Grant Date, an employee, director or officer of, or consultant or advisor to, the Company or any other entity the employees, officers, directors, consultants, or advisors of which are eligible to receive option grants under the Plan (an "Eligible Participant").

(c) Termination of Relationship with the Company. If the Participant ceases to be an Eligible Participant for any reason, then, except as provided in paragraphs (d) and (e) below, the right to exercise this option shall terminate three months after such cessation (but in no event after the Final Exercise Date), provided that this option shall be exercisable only to the extent that the Participant was entitled to exercise this option on the date of such cessation.

Notwithstanding the foregoing, if the Participant, prior to the Final Exercise Date, violates the restrictive covenants (including, without limitation, the non-competition, non-solicitation, or confidentiality provisions) of any employment contract, the Non-Competition, Non-Solicitation, Confidentiality and Assignment of Inventions agreement to which the Participant is a party, if any, or any other agreement between the Participant and the Company, the right to exercise this option shall terminate immediately upon such violation.

(d) Exercise Period Upon Death or Disability. If the Participant dies or becomes disabled (within the meaning of Section 22(e)(3) of the Code) prior to the Final Exercise Date while he or she is an Eligible Participant and the Company has not terminated such relationship for "cause" as specified in paragraph (e) below, this option shall be exercisable, within the period of one year following the date of death or disability of the Participant, by the Participant (or in the case of death by an authorized transferee), provided that this option shall be exercisable only to the extent that this option was exercisable by the Participant on the date of his or her death or disability, and further provided that this option shall not be exercisable after the Final Exercise Date.

(e) Termination for Cause. If, prior to the Final Exercise Date, the Participant's employment or other relationship with the Company is terminated by the Company for Cause (as defined below), the right to exercise this option shall terminate immediately upon the effective date of such termination of employment or other relationship. If, prior to the Final Exercise Date, the Participant is given notice by the Company of the termination of his or her employment or other relationship by the Company for Cause, and the effective date of such termination is subsequent to the date of delivery of such notice, the right to exercise this option shall be suspended from the time of the delivery of such notice until the earlier of (i) such time as it is determined or otherwise agreed that the Participant's employment or other relationship shall not be terminated for Cause as provided in such notice or (ii) the effective date of such termination (in which case the right to exercise this option shall, pursuant to the preceding sentence, terminate upon the effective date of such termination). If the Participant is subject to an individual employment or other services agreement with the Company or eligible to participate in a Company severance plan or arrangement, in any case which agreement, plan or arrangement contains a definition of "cause" for termination of employment or such other relationship, "Cause" shall have the meaning ascribed to such term in such agreement, plan or arrangement. Otherwise, "Cause" shall mean, with respect to the Participant (a) dishonesty with respect to the Company or any affiliate, (b) insubordination, substantial malfeasance or non-feasance of duty, (c) unauthorized disclosure of confidential information, (d) breach by the Participant of any provision of any employment, consulting, advisory, nondisclosure, non-competition or similar agreement between the Participant and the Company or any affiliate, and (e) conduct substantially prejudicial to the business of the Company or any affiliate. The determination of the administrator of the Plan as to the existence of Cause will be conclusive on the Participant and the Company. The Participant's employment or other relationship shall be considered to have been terminated for Cause if the Company determines, within 30 days after the Participant's resignation, that termination for Cause was warranted.

4. Withholding.

No Shares will be issued pursuant to the exercise of this option unless and until the Participant pays to the Company, or makes provision satisfactory to the Company for payment of, any federal, state or local withholding taxes required by law to be withheld in respect of this option.

5. Transfer Restrictions; Clawback.

(a) This option may not be sold, assigned, transferred, pledged or otherwise encumbered by the Participant, either voluntarily or by operation of law, except by will or the laws of descent and distribution, and, during the lifetime of the Participant, this option shall be exercisable only by the Participant.

(b) In accepting this option, the Participant agrees to be bound by any clawback policy that the Company may adopt in the future.

6. Provisions of the Plan.

This option is subject to the provisions of the Plan (including the provisions relating to amendments to the Plan), a copy of which is furnished to the Participant with this option.

ANNEX A

X4 PHARMACEUTICALS, INC.

Stock Option Exercise Notice

X4 Pharmaceuticals, Inc.
955 Massachusetts Avenue, 4th Floor
Cambridge, MA 02139

Dear Sir or Madam:

I, (the "Participant"), hereby irrevocably exercise the right to purchase _____ shares of the Common Stock, $0.001 par value per share (the "Shares"), of X4 Pharmaceuticals, Inc. (the "Company") at $_____ per share pursuant to the Company's 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan) and a stock option agreement with the Company dated _____ (the "Option Agreement"). Enclosed herewith is a payment of $_____, the aggregate purchase price for the Shares. The certificate for the Shares should be registered in my name as it appears below or, if so indicated below, jointly in my name and the name of the person designated below, with right of survivorship.

Dated: _____
Signature
Print Name:

Address: _____

_____

Name and address of persons in whose name the Shares are to be jointly registered (if applicable):

_____

Exhibit 10.17

FORM FOR ARSANIS, INC. 2017 EQUITY INCENTIVE PLAN
(MARCH 2019)

X4 PHARMACEUTICALS, INC.

INCENTIVE STOCK OPTION AGREEMENT

X4 Pharmaceuticals, Inc. (the "Company") hereby grants the following stock option pursuant to its 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan). The terms and conditions attached hereto are also a part hereof.

Notice of Grant

Name of optionee (the "Participant"):	
Grant Date:	
Number of shares of the Company's Common Stock subject to this option ("Shares"):	
Option exercise price per Share:[1/]	
Number, if any, of Shares that vest immediately on the grant date:	
Shares that are subject to vesting schedule:	
Vesting Start Date:	
Final Exercise Date: [2/]	

Vesting Schedule:

All vesting is dependent on the Participant remaining an Eligible Participant as provided herein.	
[Notwithstanding the foregoing, 100% of the unvested portion of this option shall vest upon the termination of the Participant's employment by the Company without Cause upon or at any time within 12 months following a Change of Control. For purposes of this option, a "Change of Control" shall mean the occurrence of any of the following events: (i) any "Person" (as such term is used in Sections 13(d) and 14(d) of the Exchange Act) becomes the "Beneficial Owner" (as defined in Rule 13d-3 under the Exchange Act), directly or indirectly, of securities of the Company representing fifty percent (50%) or more of the total voting power represented by the Company's then outstanding voting securities (excluding for this purpose any such voting securities held by the Company, or any affiliate, parent or subsidiary of the Company, or by any employee benefit plan of the Company) pursuant to a transaction or a series of related transactions which the Board does not approve; or (ii) (A) A merger or consolidation of the Company whether or not approved by the Board, other than a merger or consolidation which would result in the voting securities of the Company outstanding immediately prior thereto continuing to represent (either by remaining outstanding or by being converted into voting securities of the surviving entity or the parent of such entity) at least fifty percent (50%) of the total voting power represented by the voting securities of the Company or such surviving entity or parent of such entity, as the case may be, outstanding immediately after such merger or consolidation; or (B) the sale or disposition by the Company of all or substantially all of the Company's assets.]	

1/ This must be at least 100% of the Grant Date Fair Market Value (as defined in the Plan) of the Common Stock on the date of grant (or 110% in the case of a Participant that owns more than 10% of the total combined voting power of all classes of stock of the Company or its parent or subsidiary (a "10% Shareholder")) for the option to 2 qualify as an incentive stock option (an "ISO") under Section 422 of the Code.

2/ The Final Exercise Date must be no more than 10 years (5 years in the case of a 10% Shareholder) from the date of grant for the option to qualify as an ISO. The correct approach to calculate the final exercise date is to use the day immediately prior to the date ten years out from the date of the stock option award grant (5 years in the case of a 10% stockholder). For example, an award granted to someone on August 1, 2017 would expire on July 31, 2027 (not on August 1, 2027).

This option satisfies in full all commitments that the Company has to the Participant with respect to the issuance of stock, stock options or other equity securities.

X4 PHARMACEUTICALS, INC.

By: _____

Signature of Participant

Name of Officer
Title:

Street Address

City/State/Zip Code

X4 PHARMACEUTICALS, INC.

Incentive Stock Option Agreement
Incorporated Terms and Conditions

1. Grant of Option.

This agreement evidences the grant by the Company, on the grant date (the "Grant Date") set forth in the Notice of Grant that forms part of this agreement (the "Notice of Grant"), to the Participant of an option to purchase, in whole or in part, on the terms provided herein and in the Arsanis, Inc. 2017 Equity Incentive Plan (the "Plan"), the number of Shares set forth in the Notice of Grant of common stock, $0.001 par value per share, of the Company ("Common Stock"), at the exercise price per Share set forth in the Notice of Grant. Unless earlier terminated, this option shall expire at 5:00 p.m., Eastern time, on the Final Exercise Date set forth in the Notice of Grant (the "Final Exercise Date").

It is intended that the option evidenced by this agreement shall be an incentive stock option as defined in Section 422 of the Internal Revenue Code of 1986, as amended, and any regulations promulgated thereunder (the "Code") to the maximum extent permitted by law. Except as otherwise indicated by the context, the term "Participant", as used in this option, shall be deemed to include any person who acquires the right to exercise this option validly under its terms.

2. Vesting Schedule.

This option will become exercisable ("vest") in accordance with the vesting schedule set forth in the Notice of Grant.

The right of exercise shall be cumulative so that to the extent the option is not exercised in any period to the maximum extent permissible it shall continue to be exercisable, in whole or in part, with respect to all Shares for which it is vested until the earlier of the Final Exercise Date or the termination of this option under Section 3 hereof or the Plan.

3. Exercise of Option.

(a) Form of Exercise. Each election to exercise this option shall be in writing, in the form of the Stock Option Exercise Notice attached as Annex A, signed by the Participant, and received by the Company at its principal office, accompanied by this agreement, or in such other form (which may be electronic) as is approved by the Company, together with payment in full in the manner provided in the Plan. The Participant may purchase less than the number of shares covered hereby, provided that no partial exercise of this option may be for any fractional share.

(b) Continuous Relationship with the Company Required. Except as otherwise provided in this Section 3, this option may not be exercised unless the Participant, at the time he or she exercises this option, is, and has been at all times since the Grant Date, an employee, director or officer of, or consultant or advisor to, the Company or any other entity the employees, officers, directors, consultants, or advisors of which are eligible to receive option grants under the Plan (an "Eligible Participant").

(c) Termination of Relationship with the Company. If the Participant ceases to be an Eligible Participant for any reason, then, except as provided in paragraphs (d) and (e) below, the right to exercise this option shall terminate three months after such cessation (but in no event after the Final Exercise Date), provided that this option shall be exercisable only to the extent that the Participant was entitled to exercise this option on the date of such cessation. Notwithstanding the foregoing, if the Participant, prior to the Final Exercise Date, violates the restrictive covenants (including, without limitation, the non-competition, non-solicitation, or confidentiality provisions) of any employment contract, the Non-Competition, Non-Solicitation, Confidentiality and Assignment of Inventions agreement to which the Participant is a party, if any, or any other agreement between the Participant and the Company, the right to exercise this option shall terminate immediately upon such violation.

(d) Exercise Period Upon Death or Disability. If the Participant dies or becomes disabled (within the meaning of Section 22(e)(3) of the Code) prior to the Final Exercise Date while he or she is an Eligible Participant and the Company has not terminated such relationship for "cause" as specified in paragraph (e) below, this option shall be exercisable, within the period of one year following the date of death or disability of the Participant, by the Participant (or in the case of death by an authorized transferee), provided that this option shall be exercisable only to the extent that this option was exercisable by the Participant on the date of his or her death or disability, and further provided that this option shall not be exercisable after the Final Exercise Date.

(e) Termination for Cause. If, prior to the Final Exercise Date, the Participant's employment is terminated by the Company for Cause (as defined in below), the right to exercise this option shall terminate immediately upon the effective date of such termination of employment. If, prior to the Final Exercise Date, the Participant is given notice by the Company of the termination of his or her employment by the Company for Cause, and the effective date of such employment termination is subsequent to the date of delivery of such notice, the right to exercise this option shall be suspended from the time of the delivery of such notice until the earlier of (i) such time as it is determined or otherwise agreed that the Participant's employment shall not be terminated for Cause as provided in such notice or (ii) the effective date of such termination of employment (in which case the right to exercise this option shall, pursuant to the preceding sentence, terminate upon the effective date of such termination of employment). If the Participant is subject to an individual employment agreement with the Company or eligible to participate in a Company severance plan or arrangement, in any case which agreement, plan or arrangement contains a definition of "cause" for termination of employment, "Cause" shall have the meaning ascribed to such term in such agreement, plan or arrangement. Otherwise, "Cause" shall mean, with respect to the Participant (a) dishonesty with respect to the Company or any affiliate, (b) insubordination, substantial malfeasance or non-feasance of duty, (c) unauthorized disclosure of confidential information, (d) breach by the Participant of any provision of any employment, consulting, advisory, nondisclosure, non-competition or similar agreement between the Participant and the Company or any affiliate, and (e) conduct substantially prejudicial to the business of the Company or any affiliate. The determination of the administrator of the Plan as to the existence of Cause will be conclusive on the Participant and the Company. The Participant's employment shall be considered to have been terminated for Cause if the Company determines, within 30 days after the Participant's resignation, that termination for Cause was warranted.

4. Tax Matters.

(a) Withholding. No Shares will be issued pursuant to the exercise of this option unless and until the Participant pays to the Company, or makes provision satisfactory to the Company for payment of, any federal, state or local withholding taxes required by law to be withheld in respect of this option.

(b) Disqualifying Disposition. If the Participant disposes of Shares acquired upon exercise of this option within two years from the Grant Date or one year after such Shares were acquired pursuant to exercise of this option, the Participant shall notify the Company in writing of such disposition.

5. Transfer Restrictions; Clawback.

(a) This option may not be sold, assigned, transferred, pledged or otherwise encumbered by the Participant, either voluntarily or by operation of law, except by will or the laws of descent and distribution, and, during the lifetime of the Participant, this option shall be exercisable only by the Participant.

(b) In accepting this option, the Participant agrees to be bound by any clawback policy that the Company may adopt in the future.

6. Provisions of the Plan.

This option is subject to the provisions of the Plan (including the provisions relating to amendments to the Plan), a copy of which is furnished to the Participant with this option.

ANNEX A

X4 PHARMACEUTICALS, INC.

Stock Option Exercise Notice

X4 Pharmaceuticals, Inc.
955 Massachusetts Avenue, 4th Floor
Cambridge, MA 02139

Dear Sir or Madam:

I, (the "Participant"), hereby irrevocably exercise the right to purchase _____ shares of the Common Stock, $0.001 par value per share (the "Shares"), of X4 Pharmaceuticals, Inc. (the "Company") at $_____ per share pursuant to the Company's 2017 Equity Incentive Plan (the Arsanis, Inc. 2017 Equity Incentive Plan) and a stock option agreement with the Company dated _____ (the "Option Agreement"). Enclosed herewith is a payment of $_____, the aggregate purchase price for the Shares. The certificate for the Shares should be registered in my name as it appears below or, if so indicated below, jointly in my name and the name of the person designated below, with right of survivorship.

Dated: _____
Signature
Print Name:

Address: _____

_____

Name and address of persons in whose name the Shares are to be jointly registered (if applicable):

_____

Exhibit 31.1

CERTIFICATIONS UNDER SECTION 302

I, Paula Ragan, Ph.D., certify that:

1. I have reviewed this quarterly report on Form 10-Q of X4 Pharmaceuticals, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: May 15, 2019

/s/ Paula Ragan, Ph.D.
Paula Ragan, Ph.D.
President, Chief Executive Officer and Secretary
(principal executive officer)

Exhibit 31.2

CERTIFICATIONS UNDER SECTION 302

I, Adam S. Mostafa, certify that:

1. I have reviewed this quarterly report on Form 10-Q of X4 Pharmaceuticals, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: May 15, 2019

/s/ Adam S. Mostafa
Adam S. Mostafa
Chief Financial Officer and Treasurer
(principal financial officer and principal accounting officer)

Exhibit 32.1

CERTIFICATIONS UNDER SECTION 906

Pursuant to section 906 of the Sarbanes-Oxley Act of 2002 (subsections (a) and (b) of section 1350, chapter 63 of title 18, United States Code), each of the undersigned officers of X4 Pharmaceuticals, Inc., a Delaware corporation (the "Company"), does hereby certify, to such officer's knowledge, that:

The Quarterly Report for the quarter ended March 31, 2019 (the "Form 10-Q") of the Company fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934, as amended, and the information contained in the Form 10-Q fairly presents, in all material respects, the financial condition and results of operations of the Company.

Dated: May 15, 2019

/s/ Paula Ragan, Ph.D.
Paula Ragan, Ph.D.
President, Chief Executive Officer and Secretary
(principal executive officer)

Dated: May 15, 2019

/s/ Adam S. Mostafa
Adam S. Mostafa
Chief Financial Officer and Treasurer
(principal financial officer and principal accounting officer)