Filed pursuant to Rule 424(b)(5)
Registration No. 333-221479

PROSPECTUS

$75,000,000

Kura Oncology, Inc.

Common Stock

On November 9, 2017, we entered into an amendment, or the amendment, to our sales agreement, dated January 27, 2017, or the sales agreement, with Cowen and Company, LLC, or Cowen. The sales agreement, as amended, shall be referred to herein as the amended sales agreement. Under the amendment, we increased the maximum aggregate offering price of the shares of our common stock that we may offer and sell from time to time through Cowen under the sales agreement from $25.0 million to $100.0 million. This prospectus only relates to such $75.0 million of additional shares of common stock.

Our common stock is listed on the Nasdaq Global Select Market under the symbol "KURA." On November 27, 2017, the last reported sale price of our common stock on the Nasdaq Global Select Market was $16.65 per share.

Sales of our common stock, if any, under this prospectus may be made in sales deemed to be "at the market offerings" as defined in Rule 415 promulgated under the Securities Act of 1933, as amended, or the Securities Act, including sales made directly on or through the Nasdaq Global Select Market, the existing trading market for our common stock, or any other existing trading market for our common stock. Cowen is not required to sell any specific number or dollar amount of securities, but will act as a sales agent, or the sales agent, using commercially reasonable efforts consistent with its normal trading and sales practices, on mutually agreed terms between Cowen and us. There is no arrangement for funds to be received in any escrow, trust or similar arrangement.

The compensation to Cowen for sales of common stock sold pursuant to the amended sales agreement will be an amount equal to up to 3.0% of the gross proceeds of any shares of common stock sold under the amended sales agreement. See "Plan of Distribution" beginning on page S-19 for additional information regarding the compensation to be paid to Cowen. In connection with the sale of the common stock on our behalf, Cowen will be deemed to be an "underwriter" within the meaning of the Securities Act and the compensation of Cowen will be deemed to be underwriting commissions or discounts. We have also agreed to provide indemnification and contribution to Cowen with respect to certain liabilities, including liabilities under the Securities Act or the Exchange Act of 1934, as amended, or the Exchange Act.

Investing in our securities involves a high degree of risk. You should review carefully the risks and uncertainties described under the heading "Risk Factors" on page S-7 of this prospectus and under similar headings in the other documents that are incorporated by reference into this prospectus.

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

Cowen

The date of this prospectus is December 4, 2017.

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ABOUT THIS PROSPECTUS

This prospectus is part of a registration statement that we have filed with the Securities and Exchange Commission, or the SEC, utilizing a “shelf” registration process. Under the shelf registration process, we may offer shares of our common stock having a total aggregate offering price of up to $200,000,000. Under this prospectus, we may offer shares of our common stock having a total aggregate offering price of up to $75,000,000 from time to time at prices and on terms to be determined by market conditions at the time of offering.

Before buying any of the common stock that we are offering, we urge you to carefully read this prospectus, together with the information incorporated by reference in this prospectus, and any free writing prospectus that we have authorized for use in connection with this offering when making your investment decision. You should also read and consider the information in the documents we have referred you to under the headings “Where You Can Find More Information” and “Incorporation of Certain Information by Reference.” These documents contain important information that you should consider when making your investment decision.

This prospectus describes the terms of this offering of common stock and also adds to and updates information contained in the documents incorporated by reference into this prospectus. To the extent there is a conflict between the information contained in this prospectus and the information contained in any document incorporated by reference into this prospectus that was filed with the SEC before the date of this prospectus, you should rely on the information in this prospectus. If any statement in one of these documents is inconsistent with a statement in another document having a later date—for example, a document incorporated by reference into this prospectus—the statement in the document having the later date modifies or supersedes the earlier statement.

You should rely only on the information contained in or incorporated by reference in this prospectus and any free writing prospectus that we have authorized for use in connection with this offering. We have not, and the sales agent has not, authorized anyone to provide you with different information. If anyone provides you with different or inconsistent information, you should not rely on it. We are not, and the sales agent is not, making an offer to sell these securities in any jurisdiction where the offer or sale is not permitted.

You should assume that the information appearing in this prospectus, the documents incorporated by reference in this prospectus and any free writing prospectus that we have authorized for use in connection with this offering, is accurate only as of the date of those respective documents. Our business, financial condition, results of operations and prospects may have changed since those dates. You should read this prospectus, the documents incorporated by reference in this prospectus and any free writing prospectus that we have authorized for use in connection with this offering, in their entirety before making an investment decision.

Unless otherwise stated or unless the context requires otherwise, all references in this prospectus to “Kura,” “company,” “we,” “us” and “our” or similar references refer to Kura Oncology, Inc.

This prospectus and the information incorporated by reference herein include trademarks, service marks and trade names owned by us or other companies. All trademarks, service marks and trade names included or incorporated by reference into this prospectus are the property of their respective owners.

PROSPECTUS SUMMARY

This summary highlights certain information about us, this offering and selected information contained elsewhere in or incorporated by reference into this prospectus. This summary is not complete and does not contain all of the information that you should consider before deciding whether to invest in our common stock. For a more complete understanding of our company and this offering, we encourage you to read and consider carefully the more detailed information in this prospectus, including the information incorporated by reference in this prospectus, and the information included in any free writing prospectus that we have authorized for use in connection with this offering, including the information under the heading "Risk Factors" in this prospectus on page S-7 and under similar headings in the documents incorporated by reference into this prospectus.

Company Overview

We are a clinical-stage biopharmaceutical company committed to realizing the promise of precision medicines for the treatment of cancer. Our pipeline consists of small molecule product candidates that target cancer signaling pathways, and we intend to pair them with molecular or cellular diagnostics to identify those patients most likely to respond to treatment. We intend to advance our product candidates through a combination of internal development and strategic partnerships and maintain significant development and commercial rights.

Our lead product candidate, tipifarnib, is a potent, selective and orally bioavailable inhibitor of farnesyl transferase. Tipifarnib has been studied in more than 5,000 cancer patients and has demonstrated compelling and durable anti-cancer activity in certain patients with a manageable side effect profile. We are evaluating tipifarnib in a Phase 2 clinical trial in patients with Harvey rat sarcoma viral oncogene homolog, or HRAS, mutant relapsed or refractory head and neck squamous cell carcinomas, or HNSCC. In September 2017, we announced that our Phase 2 clinical trial of tipifarnib in patients with HRAS mutant HNSCC achieved its primary endpoint of response rate prior to the completion of enrollment. The clinical trial protocol required four confirmed, partial responses, per RECIST 1.1 criteria, out of 18 patients to meet its primary endpoint. Four confirmed, partial responses and two patients with disease stabilization have been observed among the first six evaluable HNSCC patients enrolled in the clinical trial. In addition, objective responses greater than one year in duration have been observed in two patients. All patients joined the study upon progression on prior therapy, including chemotherapy, cetuximab, pembrolizumab or nivolumab. Updated data from the clinical trial was presented at the AACR-NCI-EORTC International Conference on Molecular Targets and Cancer Therapeutics in October 2017 in Philadelphia, PA. We are continuing to enroll HRAS mutant HNSCC patients in the ongoing Phase 2 clinical trial. We plan to seek feedback from the U.S. Food and Drug Administration in addition to other regulatory authorities, regarding the requirements for registration of tipifarnib in the HRAS mutant HNSCC indication and initiate the required clinical program in 2018.

We are also evaluating tipifarnib in three other Phase 2 clinical trials: in patients with peripheral T-cell lymphomas, or PTCL; in patients with myelodysplastic syndromes, or MDS; and in patients with chronic myelomonocytic leukemia, or CMML. Our goals with these ongoing Phase 2 clinical trials of tipifarnib are to confirm the clinical activity of tipifarnib, to validate biomarker hypotheses, to optimize dose and schedule for each disease, and to determine whether the data are supportive of continued clinical development in each disease indication. We expect to report preliminary data from our CMML clinical trial in December 2017 followed by updated data from the trial in 2018. We also expect to report data from our PTCL and MDS clinical trials in 2018.

Our second product candidate is KO-947, a potent and selective small molecule inhibitor of extracellular signal related kinase, which we are advancing as a potential treatment for patients with

tumors that have mutations in, or other dysregulation of, the mitogen-activated protein kinase signaling pathway. Prolonged pathway inhibition and evidence of durable tumor regression have been observed with KO-947 in preclinical models, and the drug-like properties of KO-947 support an intravenous formulation, which may allow for higher drug concentration, and potentially improved tolerability in the clinic. Our preclinical data suggests that KO-947 has anti-tumor activity in Kirsten rat sarcoma viral oncogene homolog (KRAS)- and B-Raf proto-oncogene, serine/threonine kinase (BRAF)-mutant adenocarcinomas as well as squamous cell carcinomas. We are evaluating KO-947 in a Phase 1 dose escalation clinical trial in patients with locally advanced unresectable or metastatic, relapsed and/or refractory, non-hematological malignancies. We anticipate reporting data from our Phase 1 clinical trial in 2018.

Our third program is focused on KO-539, a potent and selective small molecule inhibitor of the menin-mixed lineage leukemia, or menin-MLL, protein-protein interaction. The menin-MLL complex appears to play important roles in diverse leukemias and myeloproliferative disorders driven by several distinct oncogenic driver mutations. We presented preclinical data at the EORTC-NCI-AACR International Conference on Molecular Targets and Cancer Therapeutics in October 2017. Our preclinical data demonstrates that inhibitors of the menin-MLL interaction induced robust and durable regressions in multiple models of MLL-rearranged leukemias as well as NMP1/DNMT3A-mutant acute myeloid leukemia, or AML, which together represent approximately 50% of diagnosed cases of AML. We nominated KO-539 as a development candidate for this program in December 2016.

Recent Developments

On January 27, 2017, we entered into the sales agreement with Cowen, as sales agent. Under the sales agreement, we may offer and sell, from time to time, shares of our common stock having up to an aggregate offering price of $25.0 million through “at the market offerings”. As of November 27, 2017, we had sold 14,300 shares under the sales agreement for an aggregate offering price of $163,000. On November 9, 2017, we entered into the amendment with Cowen to increase the maximum aggregate offering price of the shares of our common stock that we may offer and sell, from time to time, under the sales agreement through “at the market offerings” from $25.0 million to $100.0 million. This prospectus only relates to the $75.0 million of additional shares of common stock that may be offered and sold as a result of the amendment. Unless stated otherwise, references to “this offering” throughout this prospectus refer only to the offering of such $75.0 million of additional shares of common stock.

Risks Associated with our Business

Our business is subject to numerous risks and uncertainties, including those highlighted in the section titled “Risk Factors” immediately following this prospectus summary and those described under similar headings in the documents incorporated by reference into this prospectus. These risks include:

- We expect to incur losses over the next several years and may never achieve or maintain profitability.
- We are a clinical-stage company with no approved products and no historical product revenue. Consequently, we expect that our financial and operating results will vary significantly from period to period.
- Our limited operating history may make it difficult for you to evaluate the success of our business to date and to assess our future viability.
- We will need to obtain substantial additional capital in connection with our continuing operations. Raising additional capital may cause dilution to our stockholders, restrict our operations or require us to relinquish rights to our technologies or product candidates.

- Our discovery, preclinical and clinical development is focused on the development of targeted therapeutics for patients with genetically defined cancers, which is a rapidly evolving area of science, and the approach we are taking to discover and develop drugs may never lead to marketable products.
- Our research and development programs and product candidates are at an early stage of development. As a result we are unable to predict if or when we will successfully develop or commercialize our product candidates.
- Difficulty in enrolling patients could delay or prevent clinical trials of our product candidates.
- Clinical drug development involves a lengthy and expensive process with an uncertain outcome. We may incur additional costs or experience delays in completing, or ultimately be unable to complete, the development and commercialization of our product candidates.
- Our product candidates may cause serious adverse events or have unacceptable side effects that could delay, limit or prevent their development.
- Failure to successfully validate, develop and obtain regulatory approval for companion diagnostics for our product candidates could harm our drug development strategy and operational results.
- If we are not able to obtain, or if there are delays in obtaining, required regulatory approvals, we will not be able to commercialize our product candidates, and our ability to generate revenue will be materially impaired.
- We may not be able to obtain orphan drug exclusivity for the product candidates for which we seek it, which could limit the potential profitability of such product candidates.
- We depend on third parties for the manufacture of our product candidates for preclinical and clinical testing and expect to continue to do so for commercialization. This reliance on third parties increases the risk that we will not have sufficient quantities of our product candidates or products at an acceptable cost and quality, which could delay, prevent or impair our development or commercialization efforts.
- We face substantial competition, which may result in others discovering, developing or commercializing competing products before or more successfully than we do.
- If we are unable to obtain and maintain intellectual property protection for our technology and products, or if the scope of the intellectual property protection obtained is not sufficiently broad, our competitors could develop and commercialize technology and products similar or identical to ours, and our ability to successfully commercialize our technology and products may be impaired.
- We currently have a limited number of employees, are highly dependent on our Chief Executive Officer and our future success depends on our ability to retain key executives and to attract, retain and motivate qualified personnel.

Corporate Information

We were originally incorporated in the State of Delaware in November 2007 under the name “Zeta Acquisition Corp. III,” or Zeta. Zeta was a “shell” company registered under the Exchange Act with no specific business plan or purpose until it began operating the business of Kura Oncology, Inc., a privately held company incorporated in Delaware, or Prior Kura, through a reverse merger transaction on March 6, 2015, or the Merger. Prior Kura was incorporated in the State of Delaware in August 2014 to focus primarily on discovering and developing personalized therapeutics for the treatment of solid tumors and blood cancers. In connection with the Merger, Prior Kura changed its name to “Kura Operations, Inc.” and Zeta changed its name to “Kura Oncology, Inc.” In addition, on March 31, 2015, Kura Operations, Inc. merged with and into us and we continued as the surviving entity.

Our corporate headquarters are located at 3033 Science Park Road, Suite 220, San Diego, California 92121, and our telephone number is (858) 500-8800. We also occupy offices in Cambridge, Massachusetts. We maintain a website at www.kuraoncology.com. We do not incorporate by reference into this prospectus the information on, or accessible through, our website, and you should not consider it as part of this prospectus.

We are an “emerging growth company,” as defined in the Jumpstart Our Business Startups Act, or JOBS Act. We will remain an emerging growth company until the earlier of (1) December 31, 2020, (2) the last day of the fiscal year in which we have total annual gross revenue of at least $1.0 billion, (3) the day we are deemed to be a large accelerated filer, which means the market value of our common stock that is held by non-affiliates exceeded $700.0 million as measured as of the prior June 30th, and (4) the date on which we have issued more than $1.0 billion in non-convertible debt during the prior three-year period. References herein to “emerging growth company” shall have the meaning associated with it in the JOBS Act.

THE OFFERING

Common Stock Offered By Us	Shares of our common stock having an aggregate offering price of up to $75.0 million.
Manner of Offering	“At the market offering” that may be made from time to time through our sales agent, Cowen. See “Plan of Distribution” on page S-19 of this prospectus.
Use of Proceeds	We currently intend to use the net proceeds from this offering primarily to fund the research and development of the clinical and preclinical product candidates in our pipeline and for working capital and general corporate purposes. See “Use of Proceeds” on page S-11 of this prospectus.
Risk Factors	Investing in our common stock involves significant risks. See “Risk Factors” on page S-7 of this prospectus, and under similar headings in other documents incorporated by reference into this prospectus.
Nasdaq Global Select Market Symbol	“KURA”.

RISK FACTORS

Investing in our securities involves a high degree of risk. You should carefully review the risks and uncertainties described below and under the section titled "Risk Factors" in our Annual Report on Form 10-K for the year ended December 31, 2016, as updated by our annual, quarterly and other reports and documents that are incorporated by reference into this prospectus and any free writing prospectus that we have authorized for use in connection with this offering, before deciding whether to invest in our common stock. Each of the risk factors could adversely affect our business, operating results and financial condition, as well as adversely affect the value of an investment in our securities, and the occurrence of any of these risks might cause you to lose all or part of your investment. There may be additional risks that we do not presently know of or that we currently believe are immaterial which could also impair our business and financial position. Please also read carefully the following section titled "Special Note Regarding Forward-Looking Statements."

Additional Risks Related to This Offering

You may experience dilution.

The offering price per share in this offering may exceed the net tangible book value per share of our common stock outstanding prior to this offering. Assuming that an aggregate of 4,504,504 shares of our common stock are sold in this offering at a price of $16.65 per share, the last reported sale price of our common stock on the Nasdaq Global Select Market on November 27, 2017, for aggregate gross proceeds of $75.0 million, and after deducting commissions and estimated offering expenses payable by us, you would experience immediate dilution of $11.83 per share, representing the difference between our as adjusted net tangible book value per share as of September 30, 2017, after giving effect to this offering, and the assumed offering price. The exercise of outstanding stock options and warrants would result in further dilution of your investment. See the section entitled "Dilution" below for a more detailed illustration of the dilution you would incur if you participate in this offering. Because the sales of the shares offered hereby will be made directly into the market or in negotiated transactions, the prices at which we sell these shares will vary and these variations may be significant. Purchasers of the shares we sell, as well as our existing shareholders, will experience significant dilution if we sell shares at prices significantly below the price at which they invested.

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

To raise additional capital, we may in the future offer additional shares of our common stock or other securities convertible into or exchangeable for our common stock at prices that may not be the same as the price per share in this offering. We may sell shares or other securities in any other offering at a price per share that is less than the price per share paid by investors in this offering, and investors purchasing shares or other securities in the future could have rights superior to existing stockholders. The price per share at which we sell additional shares of our common stock, or securities convertible or exchangeable into common stock, in future transactions may be higher or lower than the price per share paid by investors in this offering. For example, under the amended sales agreement, we may offer and sell, from time to time, shares of our common stock having up to an aggregate offering price of $100.0 million through "at the market offerings". As of November 27, 2017, we had sold 14,300 shares under the sales agreement at an average price of $11.39 per share for an aggregate offering price of $163,000.

Our management might apply the net proceeds from this offering in ways with which you do not agree and in ways that may impair the value of your investment.

We currently intend to use the net proceeds from this offering primarily to fund the research and development of the clinical and preclinical product candidates in our pipeline and for working capital and general corporate purposes. Pending these uses, we expect to invest the net proceeds primarily in money market mutual funds, obligations of the U.S. government and its agencies, money market instruments including commercial paper and negotiable certificates of deposit and corporate bonds. Our management has broad discretion as to the use of such proceeds and you will be relying on the judgment of our management regarding the application of these proceeds. Our management might apply these proceeds in ways with which you do not agree, or in ways that ultimately do not yield a favorable return. If our management applies such proceeds in a manner that does not yield a significant return, if any, on our investment of such net proceeds, it could compromise our ability to pursue our growth strategy and adversely affect the market price of our common stock.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This prospectus, the documents we file with the SEC that are incorporated by reference in this prospectus and any free writing prospectus that we have authorized for use in connection with this offering, contain "forward-looking statements" within the meaning of Section 27A of the Securities Act and Section 21E of the Exchange Act. These are based on our management's current beliefs, expectations and assumptions about future events, conditions and results and on information currently available to us. Discussions containing these forward-looking statements may be found, among other places, in the Sections entitled "Business," "Risk Factors" and "Management's Discussion and Analysis of Financial Condition and Results of Operations" incorporated by reference from our most recent Annual Report on Form 10-K and in our Quarterly Reports on Form 10-Q, as well as any amendments thereto, filed with the SEC.

Any statements in this prospectus or incorporated herein about our expectations, beliefs, plans, objectives, assumptions or future events or performance are not historical facts and are forward-looking statements. These forward-looking statements include statements regarding:

- the initiation, cost, timing, progress and results of our research and development activities, clinical trials and preclinical studies;
- the early stage of products under development;
- 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, and/or warnings in the label of any approved product candidates;
- our ability to attract collaborators with development, regulatory and commercialization expertise;
- our ability to obtain and maintain intellectual property protection for our product candidates;
- our ability to successfully commercialize our product candidates;
- our plans to research, develop and commercialize our future product candidates;
- the size and growth of the markets for our product candidates and our ability to serve those markets;
- the rate and degree of market acceptance of any future products;
- the success of competing drugs that are or become available;
- government regulation;
- regulatory developments in the United States and other countries;
- the performance of our third-party suppliers and manufacturers and our ability to obtain alternative sources of raw materials;
- our ability to obtain additional financing;
- our use of cash, cash equivalents, investments and other resources;
- our use of the proceeds from this offering;
- our expectations regarding the period during which we qualify as an emerging growth company under the JOBS Act;
- the accuracy of our estimates regarding expenses, future revenues, capital requirements and the need for additional financing; and
- our ability to attract and retain key management, scientific or clinical personnel.

In some cases, you can identify forward-looking statements by terms such as "may," "will," "should," "could," "would," "expect," "plan," "anticipate," "believe," "estimate," "project," "predict," "potential" and similar expressions intended to identify forward-looking statements. These statements

reflect our current views with respect to future events and are based on assumptions and are subject to risks and uncertainties. Given these uncertainties, you should not place undue reliance on these forward-looking statements. We discuss in greater detail many of these risks under the heading “Risk Factors” contained in this prospectus, in any free writing prospectuses we may authorize for use in connection with a specific offering, and in our most recent Annual Report on Form 10-K and Quarterly Reports on Form 10-Q, as well as any amendments thereto reflected in subsequent filings with the SEC, which are incorporated by reference into this prospectus in their entirety. Also, these forward-looking statements represent our estimates and assumptions only as of the date of the document containing the applicable statement. Unless required by law, we undertake no obligation to update or revise any forward-looking statements to reflect new information or future events or developments. Thus, you should not assume that our silence over time means that actual events are bearing out as expressed or implied in such forward-looking statements. You should read this prospectus, together with the documents we have filed with the SEC that are incorporated by reference and any free writing prospectus that we may authorize for use in connection with this offering, completely and with the understanding that our actual future results may be materially different from what we expect. We qualify all of the forward-looking statements in the foregoing documents by these cautionary statements.

USE OF PROCEEDS

We may issue and sell shares of our common stock having aggregate sales proceeds of up to $75.0 million from time to time in this offering. Because there is no minimum offering amount required as a condition to close this offering, the actual total public offering amount, commissions and proceeds to us, if any, are not determinable at this time. There can be no assurance that, in the future, we will sell any shares under or fully utilize the amended sales agreement with Cowen as a source of financing.

We currently intend to use the net proceeds from this offering primarily to fund the research and development of the clinical and preclinical product candidates in our pipeline and for working capital and general corporate purposes. We may also use a portion of the net proceeds to acquire or invest in businesses, products and technologies that are complementary to our own, although we have no current plans, commitments or agreements with respect to any acquisitions as of the date of this prospectus. Pending these uses, we expect to invest the net proceeds primarily in money market mutual funds, obligations of the U.S. government and its agencies, money market instruments including commercial paper and negotiable certificates of deposit and corporate bonds.

DILUTION

Our historical net tangible book value as of September 30, 2017 was approximately $89.2 million, or $3.06 per share. Historical net tangible book value per share is determined by dividing our total tangible assets, less total liabilities, by the number of shares of our common stock outstanding as of September 30, 2017. Dilution with respect to net tangible book value per share represents the difference between the amount per share paid by purchasers of shares of common stock in this offering and the net tangible book value per share of our common stock immediately after this offering.

After giving effect to the assumed sale of 4,504,504 shares of our common stock in this offering at an assumed offering price of $16.65 per share, the last reported sale price of our common stock on the Nasdaq Global Select Market on November 27, 2017, and after deducting estimated offering commissions and offering expenses payable by us, our as adjusted net tangible book value as of September 30, 2017 would have been approximately $162.0 million, or $4.82 per share. This represents an immediate increase in net tangible book value of $1.76 per share to existing stockholders and immediate dilution of $11.83 per share to investors purchasing our common stock in this offering at the assumed offering price. The following table illustrates this dilution on a per share basis:

Assumed public offering price per share		$16.65
Net tangible book value per share as of September 30, 2017	$3.06	
Increase in net tangible book value per share attributable to this offering	$1.76	
As adjusted net tangible book value per share as of September 30, 2017, after giving effect to this offering		$ 4.82
Dilution per share to investors purchasing our common stock in this offering		$11.83

The above discussion and table are based on 29,127,436 shares of our common stock outstanding as of September 30, 2017, and exclude:

- 1,090,787 shares of common stock subject to repurchase as of September 30, 2017;
- 2,171,663 shares of common stock issuable upon the exercise of stock options outstanding as of September 30, 2017, having a weighted average exercise price of $6.51 per share;
- 579,159 shares of common stock reserved for future issuance under our Amended and Restated 2014 Equity Incentive Plan, or 2014 plan, as of September 30, 2017, plus any future increases in the number of shares of common stock reserved for issuance under the 2014 plan pursuant to evergreen provisions;
- 238,705 shares of common stock reserved for future issuance under our 2015 Employee Stock Purchase Plan, or 2015 ESPP, as of September 30, 2017, plus any future increases in the number of shares of common stock reserved for issuance under the 2015 ESPP pursuant to evergreen provisions;
- 33,988 shares of common stock issuable upon the exercise of warrants outstanding as of September 30, 2017, each at an exercise price of $3.31 per share; and
- 1,491,718 shares of common stock available for sale after September 30, 2017 under the sales agreement prior to giving effect to the amendment (based on approximately $24.8 million of common stock available for sale under the sales agreement and assuming sales at a price of $16.65 per share, which was the closing price of our common stock on the Nasdaq Global Select Market on November 27, 2017).

The table above assumes for illustrative purposes that an aggregate of 4,504,504 shares of our common stock are sold pursuant to this prospectus at a price of $16.65 per share, the last reported

sale price of our common stock on the Nasdaq Global Select Market on November 27, 2017, for aggregate gross proceeds of $75.0 million. The shares sold in this offering, if any, will be sold from time to time at various prices. An increase of $1.00 per share in the price at which the shares are sold from the assumed offering price of $16.65 per share, assuming all of our common stock in the aggregate amount of $75.0 million is sold at that price, would increase our adjusted net tangible book value per share after the offering to $4.85 per share and would increase the dilution in net tangible book value per share to new investors in this offering to $12.80 per share, after deducting commissions and estimated aggregate offering expenses payable by us. A decrease of $1.00 per share in the price at which the shares are sold from the assumed offering price of $16.65 per share, assuming all of our common stock in the aggregate amount of $75.0 million is sold at that price, would decrease our adjusted net tangible book value per share after the offering to $4.78 per share and would decrease the dilution in net tangible book value per share to new investors in this offering to $10.87 per share, after deducting commissions and estimated aggregate offering expenses payable by us. This information is supplied for illustrative purposes only.

To the extent that outstanding options or warrants outstanding as of September 30, 2017 have been or may be exercised or other shares issued, investors purchasing our common stock in this offering may experience further dilution. In addition, we may choose to raise additional capital due to market conditions or strategic considerations even if we believe we have sufficient funds for our current or future operating plans. To the extent that additional capital is raised through the sale of equity or convertible debt securities, the issuance of these securities could result in further dilution to our stockholders.

DESCRIPTION OF CAPITAL STOCK

As of the date of this prospectus, our amended and restated certificate of incorporation, as amended, authorizes us to issue 200,000,000 shares of common stock, par value $0.0001 per share, and 10,000,000 shares of preferred stock, par value $0.0001 per share. As of September 30, 2017, 30,218,223 shares of common stock were outstanding, of which 1,090,787 shares were subject to repurchase, and no shares of preferred stock were outstanding.

The following summary describes the material terms of our capital stock and the registration rights under our registration rights agreement. The descriptions of capital stock and the registration rights under our registration rights agreement are qualified by reference to our amended and restated certificate of incorporation, as amended, our amended and restated bylaws and our registration rights agreement, which are incorporated by reference as exhibits into the registration statement of which this prospectus is a part.

Common Stock

Voting. Our common stock is entitled to one vote for each share held of record on all matters submitted to a vote of the stockholders, including the election of directors, and does not have cumulative voting rights. Accordingly, the holders of a majority of the shares of our common stock entitled to vote in any election of directors can elect all of the directors standing for election.

Dividends. Subject to preferences that may be applicable to any then-outstanding preferred stock, the holders of common stock are entitled to receive dividends, if any, as may be declared from time to time by our board of directors out of legally available funds.

Liquidation. In the event of our liquidation, dissolution or winding-up, holders of our common stock will be entitled to share ratably in the net assets legally available for distribution to stockholders after the payment of all of our debts and other liabilities, subject to the satisfaction of any liquidation preference granted to the holders of any outstanding shares of preferred stock.

Rights and Preferences. Holders of our common stock have no preemptive, conversion or subscription rights, and there are no redemption or sinking fund provisions applicable to our common stock. The rights, preferences and privileges of the holders of our common stock are subject to, and may be adversely affected by, the rights of the holders of shares of any series of our preferred stock that we may designate and issue in the future.

Preferred Stock

Under our amended and restated certificate of incorporation, as amended, our board of directors has the authority, without further action by stockholders, to designate up to 10,000,000 shares of preferred stock in one or more series and to fix or alter, from time to time, the designations, powers and rights of each series of preferred stock and the qualifications, limitations or restrictions of any series of preferred stock, including dividend rights, dividend rate, conversion rights, voting rights, rights and terms of redemption (including sinking fund provisions), redemption price or prices, and the liquidation preference of any wholly unissued series of preferred stock, any or all of which may be greater than the rights of the common stock, and to establish the number of shares constituting any such series. To date, none of the 10,000,000 authorized shares of preferred stock have been designated by our board of directors.

The issuance of preferred stock could adversely affect the voting power, conversion or other rights of holders of common stock and reduce the likelihood that common stockholders will receive dividend payments and payments upon liquidation. Preferred stock could be issued quickly with terms designed

to delay, deter or prevent a change in control of our company or make removal of management more difficult. Additionally, the issuance of preferred stock may have the effect of decreasing the market price of our common stock.

Registration Rights

On March 6, 2015, Prior Kura entered into a registration rights agreement with the investors in a private placement, or the Private Placement, and also the existing stockholders of Prior Kura who agreed to become parties to certain provisions of the agreement, which covered substantially all of Prior Kura's outstanding shares of common stock. We assumed the registration rights agreement in connection with the Merger.

Resale Registration Rights

Pursuant to the registration rights agreement and subject to the rules and regulations of the SEC, we filed a registration statement covering the resale of the shares of our common stock held by the investors in the Private Placement and the shares of our common stock held by the former stockholders of Prior Kura who are parties to the agreement, which we refer to as the Resale Registration Statement. The Resale Registration Statement was originally declared effective on July 21, 2015.

Registration of these shares under the Securities Act has resulted in the shares becoming saleable under the Securities Act, except for shares held by affiliates, subject to applicable lock-up restrictions. Any sales of securities by holders of these shares could adversely affect the trading prices of our common stock.

We will be liable to each investor in the Private Placement (but not to the former stockholders of Prior Kura who are parties to the registration rights agreement) for liquidated damages equal to 1.0% of the aggregate purchase price paid by the investor for the registrable shares of our common stock then held by the investor for each 30-day period, subject to an overall cap of 5%, (i) if we suspend (subject to limited blackout periods described below) or terminate the Resale Registration Statement prior to the date which is the earlier of (x) July 21, 2018 and (y) the date on which all of the registrable shares cease to be registrable shares, or (ii) in the event any suspensions or terminations of the effectiveness of the Resale Registration Statement exceeds 30 consecutive days or when taken together exceed 60 days in the aggregate during any 12-month period.

Form S-3 Demand Registration Rights

Pursuant to the registration rights agreement, at any time after we became eligible to file a registration statement on Form S-3, subject to specified limitations set forth in the registration rights agreement, certain holders of a specified percentage of the registrable shares of common stock then outstanding may request that we register on Form S-3 all or a portion of the registrable shares.

"Piggyback" Registration Rights

Pursuant to the registration rights agreement, if we propose to register any of our common stock in a firm commitment underwritten offering, certain holders of registrable shares of our common stock, in certain circumstances, will be entitled to notice of the registration and have the right to require us to register all or a portion of the registrable shares then held by them, subject to our right and the right of our underwriters to reduce the number of shares proposed to be registered in view of market conditions. No such registration rights are applicable with respect to the filing of the registration statement of which this prospectus forms a part.

Expenses of Registration

We have agreed to pay all fees and expenses relating to the Resale Registration Statement, as well as all Form S-3 demand registrations and piggyback registrations, including (i) up to $25,000 in fees of one special counsel for certain of the investors in connection with the filing of the Resale Registration Statement and (ii) up to $25,000 in fees of one special counsel for certain of the investors in connection with the filing of one or more registration statements pursuant to the Form S-3 demand and piggyback registration rights.

Expiration of Registration Rights

The resale registration rights described above shall terminate upon the earlier of (1) the date on which all registrable shares have been effectively registered under the Securities Act and disposed of in accordance with the Resale Registration Statement and (2) the later of the third anniversary of the date (A) the Resale Registration Statement was declared effective, which is July 21, 2018, and (B) all registrable shares (subject to certain limitations) have been registered in the Resale Registration Statement.

Delaware Anti-Takeover Law and Provisions of Our Amended and Restated Certificate of Incorporation, as Amended, and Amended and Restated Bylaws

Our amended and restated certificate of incorporation, as amended, and our amended and restated bylaws contain certain provisions that could have the effect of delaying, deterring or preventing another party from acquiring control of us, and therefore could adversely affect the market price of our common stock. These provisions and certain provisions of the Delaware General Corporation Law, or DGCL, which are summarized below, may also discourage coercive takeover practices and inadequate takeover bids, and are designed, in part, to encourage persons seeking to acquire control of us to negotiate first with our board of directors. We believe that the benefits of increased protection of our potential ability to negotiate more favorable terms with an unfriendly or unsolicited acquirer outweigh the disadvantages of potentially discouraging a proposal to acquire us.

Delaware Anti-Takeover Law

We are subject to Section 203 of the DGCL, or Section 203. Section 203 generally prohibits a public Delaware corporation from engaging in a “business combination” with an “interested stockholder” for a period of three years following the time that such stockholder became an interested stockholder, unless:

- prior to such time the board of directors of the corporation approved either the business combination or the transaction which resulted in the stockholder becoming an interested stockholder;
- upon consummation of the transaction which resulted in the stockholder becoming an interested stockholder, the interested stockholder owned at least 85% of the voting stock of the corporation outstanding at the time the transaction commenced, excluding for purposes of determining the voting stock outstanding (but not the outstanding voting stock owned by the interested stockholder) those shares owned (i) by persons who are directors and also officers and (ii) employee stock plans in which employee participants do not have the right to determine confidentially whether shares held subject to the plan will be tendered in a tender or exchange offer; or
- at or subsequent to such time the business combination is approved by the board of directors and authorized at an annual or special meeting of stockholders, and not by written consent, by the affirmative vote of at least 66 2/3% of the outstanding voting stock which is not owned by the interested stockholder.

Section 203 defines a business combination to include:

- any merger or consolidation involving the corporation and the interested stockholder;
- any sale, transfer, pledge or other disposition involving the interested stockholder of 10% or more of the assets of the corporation;
- subject to exceptions, any transaction that results in the issuance or transfer by the corporation of any stock of the corporation to the interested stockholder;
- subject to exceptions, any transaction involving the corporation that has the effect of increasing the proportionate share of the stock of any class or series of the corporation beneficially owned by the interested stockholder; and
- the receipt by the interested stockholder of the benefit of any loans, advances, guarantees, pledges or other financial benefits provided by or through the corporation.

In general, Section 203 defines an interested stockholder as any entity or person beneficially owning 15% or more of the outstanding voting stock of the corporation and any entity or person affiliated with or controlling or controlled by the entity or person.

Amended and Restated Certificate of Incorporation, as Amended, and Amended and Restated Bylaws

Among other things, our amended and restated certificate of incorporation, as amended, and amended and restated bylaws:

- permit our board of directors to issue up to 10,000,000 shares of preferred stock, with any rights, preferences and privileges as they may designate (including the right to approve an acquisition or other change of control);
- provide that the authorized number of directors may be changed only by resolution of our board of directors;
- provide that directors may only be removed, subject to any limitation imposed by law, with cause by the holders of at least 66 2/3% of the voting power of all of our then-outstanding shares of the capital stock entitled to vote generally at an election of directors;
- provide that all vacancies, including newly created directorships, may, except as otherwise required by law, be filled by the affirmative vote of a majority of directors then in office, even if less than a quorum;
- divide our board of directors into three classes;
- require that any action to be taken by our stockholders must be effected at a duly called annual or special meeting of stockholders and not be taken by written consent or electronic transmission;
- provide that stockholders seeking to present proposals before a meeting of stockholders or to nominate candidates for election as directors at a meeting of stockholders must provide advance notice in writing, and also specify requirements as to the form and content of a stockholder's notice;
- provide that special meetings of our stockholders may be called only by the chairman of our board of directors, our chief executive officer or by our board of directors pursuant to a resolution adopted by a majority of the total number of authorized directors (whether or not there exists any vacancies);
- do not provide for cumulative voting rights (therefore allowing the holders of a majority of the shares of common stock entitled to vote in any election of directors to elect all of the directors standing for election, if they should so choose); and
- provide that the Court of Chancery of the State of Delaware will be the sole and exclusive forum for (1) any derivative action or proceeding brought on our behalf, (2) any action

asserting a claim of breach of a fiduciary duty owed by any of our directors or officers to us or our stockholders, (3) any action asserting a claim against the us arising pursuant to any provision of the DGCL or our amended and restated certificate of incorporation, as amended, or amended and restated bylaws, or (4) any action asserting a claim against us governed by the internal affairs doctrine.

The amendment of any of these provisions, with the exception of the ability of our board of directors to issue shares of preferred stock and designate any rights, preferences and privileges thereto, would require the affirmative vote of the holders of at least 66 2/3% of the voting power of all of our then outstanding common stock.

The provisions of the DGCL and the provisions of our amended and restated certificate of incorporation, as amended, and amended and restated bylaws could have the effect of discouraging others from attempting hostile takeovers and, as a consequence, they might also inhibit temporary fluctuations in the market price of our common stock that often result from actual or rumored hostile takeover attempts. These provisions might also have the effect of preventing changes in our management. It is possible that these provisions could make it more difficult to accomplish transactions that stockholders might otherwise deem to be in their best interests.

Transfer Agent and Registrar

The transfer agent and registrar for our common stock is American Stock Transfer & Trust Company, LLC, and its address is 6201 15th Avenue, Brooklyn, NY 11219.

Listing on the Nasdaq Global Select Market

Our common stock is listed on the Nasdaq Global Select Market under the symbol “KURA”.

PLAN OF DISTRIBUTION

We entered into the sales agreement with Cowen on January 27, 2017, under which we may issue and sell from time to time shares of our common stock through Cowen as our sales agent having an aggregate offering price of up to $25,000,000. On November 9, 2017, we entered into the amendment to increase the maximum aggregate offering price of the shares of our common stock that we may issue and sell from time to time through Cowen under the sales agreement from $25,000,000 to $100,000,000. This prospectus only relates to the $75,000,000 of additional shares of common stock that may be offered and sold as a result of the amendment. Sales of our common stock under this prospectus, if any, will be made at market prices by any method that is deemed to be an "at the market offering" as defined in Rule 415 under the Securities Act, including sales made directly on the Nasdaq Global Select Market or any other trading market for our common stock. If authorized by us in writing, Cowen may purchase shares of our common stock as principal.

Cowen will offer our common stock subject to the terms and conditions of the amended sales agreement on a daily basis or as otherwise agreed upon by us and Cowen. We will designate the maximum amount of common stock to be sold through Cowen on a daily basis or otherwise determine such maximum amount together with Cowen. Subject to the terms and conditions of the amended sales agreement, Cowen will use its commercially reasonable efforts to sell on our behalf all of the shares of common stock requested to be sold by us. We may instruct Cowen not to sell common stock if the sales cannot be effected at or above the price designated by us in any such instruction. Cowen or we may suspend the offering of our common stock being made through Cowen under the amended sales agreement upon proper notice to the other party. Cowen and we each have the right, by giving written notice as specified in the amended sales agreement, to terminate the amended sales agreement in each party's sole discretion at any time.

The aggregate compensation payable to Cowen as sales agent equals up to 3.0% of the gross sales price of the shares sold through it pursuant to the amended sales agreement. We have also agreed to reimburse Cowen up to $50,000 of Cowen's actual outside legal expenses incurred by Cowen and up to $10,000 of filing fees and associated legal expenses of Cowen's outside counsel for filings with the Financial Industry Regulatory Authority Corporate Financing Department in connection with the transactions contemplated by the amended sales agreement. We estimate that the total expenses in connection with the transactions contemplated by the amended sales agreement payable by us, excluding commissions payable to Cowen under the amended sales agreement, will be approximately $300,000.

The remaining sales proceeds, after deducting any expenses payable by us and any transaction fees imposed by any governmental, regulatory, or self-regulatory organization in connection with the sales, will equal our net proceeds for the sale of such common stock.

Cowen will provide written confirmation to us following the close of trading on the Nasdaq Global Select Market on each day in which common stock is sold through it as sales agent under the amended sales agreement. Each confirmation will include the number of shares of common stock sold through it as sales agent on that day, the volume weighted average price of the shares sold, the percentage of the daily trading volume and the net proceeds to us.

Settlement for sales of common stock will occur, unless the parties agree otherwise, on the third business day that is also a trading day following the date on which any sales were made in return for payment of the net proceeds to us. There is no arrangement for funds to be received in an escrow, trust or similar arrangement.

In connection with the sales of our common stock on our behalf, Cowen may be deemed to be an "underwriter" within the meaning of the Securities Act, and the compensation paid to Cowen may be

deemed to be underwriting commissions or discounts. We have agreed in the amended sales agreement to provide indemnification and contribution to Cowen against certain liabilities, including liabilities under the Securities Act. As sales agent, Cowen will not engage in any transactions that stabilizes our common stock.

Our common stock is listed on the Nasdaq Global Select Market and trades under the symbol “KURA”. The transfer agent of our common stock is American Stock Transfer & Trust Company, LLC.

Cowen and/or its affiliates have provided, and may in the future provide, various investment banking and other financial services for us for which services they have received and, may in the future receive, customary fees.

LEGAL MATTERS

The validity of the common stock offered by this prospectus has been passed upon by Cooley LLP, San Diego, California. Proskauer Rose LLP, New York, New York, will act as counsel to Cowen and Company, LLC in connection with this offering.

EXPERTS

Ernst & Young LLP, an independent registered public accounting firm, has audited our financial statements included in our Annual Report on Form 10-K for the year ended December 31, 2016, as set forth in their report, which is incorporated by reference in this prospectus and elsewhere in the registration statement. Our financial statements are incorporated by reference in reliance on Ernst & Young LLP's report, given on their authority as experts in accounting and auditing.

WHERE YOU CAN FIND MORE INFORMATION

This prospectus is part of a registration statement we filed with the SEC. This prospectus does not contain all of the information set forth in the registration statement and the exhibits to the registration statement. For further information with respect to us and the securities we are offering under this prospectus, we refer you to the registration statement and the exhibits and schedules filed as a part of the registration statement. Neither we nor any agent, underwriter or dealer has authorized any person to provide you with information that is different from that contained in this prospectus or in any free writing prospectus we may authorize to be delivered or made available to you. We take no responsibility for, and can provide no assurance as to the reliability of, any other information that others may give you. We are not making an offer of these securities in any state where the offer is not permitted. You should not assume that the information in this prospectus is accurate as of any date other than the date on the front page of this prospectus, regardless of the time of delivery of this prospectus or any sale of the securities offered by this prospectus.

We file annual, quarterly and current reports, proxy statements and other information with the SEC. You may read and copy the registration statement, as well as any other document filed by us with the SEC, at the SEC's Public Reference Room at 100 F Street NE, Washington, D.C. 20549. You can also request copies of these documents by writing to the SEC and paying a fee for the copying cost. You may obtain information on the operation of the Public Reference Room by calling the SEC at (800) SEC-0330. The SEC maintains a website that contains reports, proxy and information statements and other information regarding issuers that file electronically with the SEC, including Kura Oncology, Inc. The address of the SEC website is www.sec.gov.

We maintain a website at www.kuraoncology.com. Information contained in or accessible through our website does not constitute a part of this prospectus and is not incorporated by reference into this prospectus.

INCORPORATION OF CERTAIN INFORMATION BY REFERENCE

The SEC allows us to "incorporate by reference" information into this prospectus, which means that we can disclose important information to you by referring you to another document filed separately with the SEC. The SEC file number for the documents incorporated by reference in this prospectus is 001- 37620. The documents incorporated by reference into this prospectus contain important information about us that you should read.

The following documents are incorporated by reference into this document:

- our Annual Report on Form 10-K for the fiscal year ended December 31, 2016 filed with the SEC on March 14, 2017;
- the information specifically incorporated by reference into our Annual Report on Form 10-K for the fiscal year ended December 31, 2016 from our definitive proxy statement on Schedule 14A (other than information furnished rather than filed) filed with the SEC on April 25, 2017;
- our Quarterly Reports on Form 10-Q for the quarterly periods ended March 31, 2017, June 30, 2017 and September 30, 2017, which were filed with the SEC on May 15, 2017, August 7, 2017 and November 7, 2017, respectively;
- our Current Reports on Form 8-K (other than information furnished rather than filed) filed with the SEC on January 3, 2017, January 27, 2017, May 25, 2017, June 14, 2017, August 11, 2017, September 7, 2017 and November 9, 2017; and
- the description of our common stock, which is registered under Section 12 of the Exchange Act, in our registration statement on Form 8-A, filed with the SEC on November 4, 2015, including any amendments or reports filed for the purpose of updating such description.

We also incorporate by reference into this prospectus all documents (other than current reports furnished under Item 2.02 or Item 7.01 of Form 8-K and exhibits filed on such form that are related to such items) that are filed by us with the SEC pursuant to Sections 13(a), 13(c), 14 or 15(d) of the Exchange Act after the date of this prospectus but prior to the termination of the offering. These documents include periodic reports, such as Annual Reports on Form 10-K, Quarterly Reports on Form 10-Q and Current Reports on Form 8-K, as well as proxy statements.

We will provide to each person, including any beneficial owner, to whom a prospectus is delivered, without charge upon written or oral request, a copy of any or all of the documents that are incorporated by reference into this prospectus but not delivered with this prospectus, including exhibits which are specifically incorporated by reference into such documents. You should direct any requests for documents by writing us at 3033 Science Park Road, Suite 220, San Diego, California 92121 Attn: Secretary or by telephoning us at (858) 500-8800.

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

$75,000,000

Kura Oncology, Inc.

Common Stock

Cowen

December 4, 2017