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

FORM 10-K

☒ **Annual report pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934**
For the fiscal year ended December 31, 2021
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 001-33957

HARVARD BIOSCIENCE, INC.
(Exact Name of Registrant as Specified in Its Charter)

Delaware	**04-3306140**
(State or other jurisdiction of Incorporation or organization)	(I.R.S. Employer Identification No.)

84 October Hill Road, Holliston, Massachusetts 01746
(Address of Principal Executive Offices, including zip code)

(508) 893-8999
(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, $0.01 par value	HBIO	The Nasdaq Global Market

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

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

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

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

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§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. (Check one):

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 has filed a report on and attestation to its management’s assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report. ☒

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

The aggregate market value of shares of voting common equity held by non-affiliates of the registrant as of June 30, 2021 was approximately $324.4 million based on the closing sales price of the registrant’s common stock, par value $0.01 per share on that date. At March 7, 2022, there were 41,230,462 shares of the registrant’s common stock issued and outstanding.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the Company’s definitive Proxy Statement in connection with the 2022 Annual Meeting of Stockholders (the “Proxy Statement”), to be filed within 120 days after the end of the Registrant’s fiscal year, are incorporated by reference into Part III of this Form 10-K. Except with respect to information specifically incorporated by reference in this Form 10-K, the Proxy Statement is not deemed to be filed as part hereof.

HARVARD BIOSCIENCE, INC.
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For the Year Ended December 31, 2021
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This Annual Report on Form 10-K contains statements that are not statements of historical fact and are forward-looking statements within the meaning of Section 27A of the Securities Act of 1933 and Section 21E of the Securities Exchange Act of 1934 (the "Exchange Act"), each as amended. The forward-looking statements are principally, but not exclusively, contained in "Item 1: Business" and "Item 7: Management's Discussion and Analysis of Financial Condition and Results of Operations." These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, performance or achievements to be materially different from any future results, performance or achievements expressed or implied by the forward-looking statements. Forward-looking statements include, but are not limited to, statements about management's confidence or expectations, our business strategy, our ability to raise capital or borrow funds to consummate acquisitions and the availability of attractive acquisition candidates, our expectations regarding future costs of product revenues, our anticipated compliance with the covenants contained in our credit facility, the adequacy of our financial resources and our plans, objectives, expectations and intentions that are not historical facts. In some cases, you can identify forward-looking statements by terms such as "may," "will," "should," "could," "would," "seek," "expects," "plans," "aim," "anticipates," "believes," "estimates," "projects," "predicts," "intends," "think," "strategy," "potential," "objectives," "optimistic," "new," "goal" 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 subject to risks and uncertainties. Given these uncertainties, you should not place undue reliance on these forward-looking statements. We discuss many of these risks in detail under the heading "Item 1A. Risk Factors" beginning on page 7 of this Annual Report on Form 10-K. You should carefully review all of these factors, as well as other risks described in our public filings, and you should be aware that there may be other factors, including factors of which we are not currently aware, that could cause these differences. Also, these forward-looking statements represent our estimates and assumptions only as of the date of this report. We may not update these forward-looking statements, even though our situation may change in the future, unless we have obligations under the federal securities laws to update and disclose material developments related to previously disclosed information. Harvard Bioscience, Inc. is referred to herein as "we," "our," "us," and "the Company."

PART I

Item 1. *Business.*

Overview

Harvard Bioscience, Inc., a Delaware corporation, is a leading developer, manufacturer and seller of technologies, products and services that enable fundamental research, discovery, and preclinical testing for drug development. Our customers range from renowned academic institutions and government laboratories, to the world's leading pharmaceutical, biotechnology and contract research organizations. With operations in North America, Europe, and China, we sell through a combination of direct and distribution channels to customers around the world.

Recent Developments

COVID-19

The COVID-19 pandemic has had a negative impact on our operations since its onset in March 2020. While the Company has improved revenues and operations during 2021, a higher degree of volatility and uncertainty in the global economy has been observed during this period, and with it uncertainty around economic impacts. Since the global outbreak of COVID-19, many customers, particularly academic research institutions, have reduced laboratory work which has negatively impacted, and will continue to negatively impact, the Company's sales. While many of the Company's customers, including academic labs, have reopened, a significant number of them remained closed or at significantly lower capacity levels during 2021. Additionally, to ensure business continuity while maintaining a safe environment for employees aligned with guidance from government and health organizations, the Company transitioned a significant portion of its workforce to work-from-home while implementing social distancing requirements and other measures to allow manufacturing and other personnel essential to production to continue work within the Company's facilities. Business travel was significantly reduced during this period. While a portion of the workforce has returned to in-office work and travel is less restricted, the Company continues to have restrictions which represent disruptions which can impact productivity including sales and marketing activities.

The global supply chain experienced significant disruptions during 2021 due to electronic component and labor shortages and other macroeconomic factors which have emerged since the onset of the COVID-19 pandemic, leading to increased cost of freight, purchased materials and manufacturing labor, while also delaying customer shipments. Accordingly, these conditions in addition to the overall impact on the global economy have negatively impacted our results of operations and cash flows.

Our History and Strategy

Our business began in 1901 under the name Harvard Apparatus. It was founded by Dr. William T. Porter, a Professor of Physiology at Harvard Medical School and a pioneer of physiology education. We have grown over the years with the development and evolution of modern life science research and education. Our early inventions included ventilators based on Dr. Porter's design, the mechanical syringe pump for drug infusion in the 1950s, and the microprocessor-controlled syringe pump in the 1980s.

In March of 1996, a group of investors acquired a majority of the then existing business of our predecessor, Harvard Apparatus, Inc. Following this acquisition, our focus was redirected to acquiring complementary companies with innovative technologies while continuing to grow the existing business through internal product development. Since 1996, we have completed multiple business or product line acquisitions related to our continuing operations. Harvard Bioscience, Inc. was incorporated in the State of Delaware in September 2000 and became the successor entity to Harvard Apparatus, Inc. by merger in November 2000.

In December 2019, we implemented a restructuring plan (the "Restructuring Plan") to deliver significant cost savings beginning in 2020 and to support delivery of the strategic action plan we announced in September 2019. The Restructuring Plan included consolidation of our Connecticut manufacturing plant to our existing Massachusetts site, downsizing of operations in the United Kingdom and a reduction in force across the business equal to approximately 10% of our headcount. The initial initiatives under the Restructuring Plan were completed in the second half of 2020.

We continued to execute the Restructuring Plan during the COVID-19 pandemic and expanded the scope of the restructuring by realigning our organizational structure to reduce management layers and accelerated our efforts to move to a leaner organization and operation. As a result of this expanded scope, we eliminated additional headcount during 2020, and in the first quarter of 2021, communicated to employees our plan to consolidate certain engineering operations and eliminate two small facilities in Europe.

In 2021 we completed cost savings initiatives and related actions related to the Restructuring Plan, and we increased our focus on effectiveness of sales and product management to deliver organic sales growth. A portion of the savings generated from the Restructuring Plan has been reinvested to support these growth initiatives.

Our Products

Our products support research in 6 different classes of laboratory use: (1) molecular, (2) cellular, (3) tissue, (4) organ, (5) organisms or preclinical and (6) clinical. We have organized our product line activities into two product families, Cellular and Molecular Technologies (CMT) and Preclinical.

Products in classes (1), (2), (3), (4) and some products in class (5) are part of CMT, which includes 14 individual business lines supporting new drug discovery and development. Our Preclinical product family includes 4 individual business lines included in class (5) which support the preclinical research phase for drug development. CMT products are primarily sold to academic and government labs and institutions. Preclinical products are primarily sold to pharmaceutical, biotechnology and contract research organizations.

We primarily sell our products under several brand names, including Harvard Apparatus, DSI, Ponemah, Buxco, Biochrom, BTX, MCS.

Our solutions range from simple to complex, and generally consist of hardware/firmware/ and software products, augmented with consumables, options, upgrades and post-sales (scientific) services. Sales prices of these products and services range from under $100 to over $100,000. Our products include spectrophotometers that analyze light to detect and quantify a wide range of molecules as well as cell analysis and electroporation and electrofusion systems to influence and/or analyze cellular processes. Other products and services focus on tissue and organ responses to new drugs and encompass wireless monitors, and signal acquisition and analysis functionality. We also feature products that monitor physiology processes in living organisms to study behavior. Many of our proprietary products are leaders in their field.

In addition to our proprietarily manufactured products, we sell factored products from other manufacturers. These distributed products accounted for approximately 14% and 15% of our revenues for the years ended December 31, 2021 and 2020, respectively. Resale of factored products enable us to act as a single source for our customers' research needs. They consist of a large variety of complementing instruments or accessories as well as consumables used in experiments involving fluid handling, molecular and cell analysis and tissue, organ and animal research. Following is a description of each product family.

Cellular and Molecular Technologies Product Family

Our CMT product family includes products designed primarily to support the discovery phase of new drug development. CMT products include:

- syringe and peristaltic pump product lines, as well as a broad range of instruments and accessories for tissue, organ-based lab research, including surgical products, infusion systems, and behavior research systems;
- electroporation and electrofusion instruments, amino acid analyzers, spectrophotometers, and other equipment which primarily support molecular level testing and research; and
- precision scientific measuring instrumentation and equipment in the field of electrophysiology such as: data acquisition systems with custom amplifier configurations for cellular analysis, complete micro electrode array solutions for in vivo recordings and in vitro systems for extracellular recordings.

Our CMT product family made up approximately 57% of our global revenues for each of the years ended December 31, 2021 and 2020.

Preclinical Product Family

Our Preclinical product family provides a complete platform to assess physiological data from organisms for research ranging from basic research to drug discovery, and drug development services. The Preclinical product family consists of the DSI and Buxco brands. It includes:

- the most comprehensive portfolio of implantable and externally-worn telemetry systems, which are commonly used in research to collect cardiovascular, central nervous system, respiratory, metabolic data;
- turn-key respiratory system solutions encompassing plethysmograph chambers, data acquisition hardware, physiological signal analysis software, and final report generation;
- inhalation and exposure systems providing precise, homogenous aerosol delivery for up to 42 subjects, while integrating respiratory parameters for the ultimate delivered dose system; and
- powerful GLP-capable data acquisition and analysis systems, capable of integrating third party sensors for a more comprehensive study design.

DSI's direct sales force supports North America, Europe, and China, with distributors supporting the rest of the world. Our Preclinical products made up approximately 43% of our global revenues for each of the years ended December 31, 2021 and 2020.

Customers

Our end-user customers are primarily research scientists at pharmaceutical and biotechnology companies, universities, hospitals, government laboratories, including the United States National Institutes of Health (NIH), and contract research organizations (CROs). Our pharmaceutical and biotechnology customers have included pharmaceutical companies and research laboratories such as Pfizer, Amgen, Inc., AstraZeneca plc, Genentech, Inc. and Johnson & Johnson. Our academic customers include major colleges and universities including Harvard University, Cambridge University, Johns Hopkins University, Massachusetts Institute of Technology, Yale University, the University of California system, Baylor College of Medicine, and the University of Texas - MD Anderson Center. Our CRO customers include Covance and Charles River Laboratories. We have a wide range of diverse customers worldwide and no customer accounted for more than 10% of our revenues in 2021.

Sales

We conduct direct sales in the United States, United Kingdom, Germany, France, Italy, Spain, Sweden, Canada and China. We sell primarily through distributors in other countries. For the year ended December 31, 2021, revenues from direct sales to end-users represented approximately 67% of our revenues; and revenues from sales of our products through distributors represented approximately 33% of our revenues.

Direct Sales

We have a global sales organization managing both direct sales and distributors. Our websites and catalogs serve as the primary sales tool for our product lines, which includes both proprietary manufactured products and complementary products from various suppliers. Our reputation as a leading producer of many of our manufactured products creates traffic to our websites, enables cross-selling and facilitates the introduction of new products.

Sales through Distributors

We engage distributors for the sales of our own branded and private label products in certain areas of the world and for certain product lines.

Marketing

We have a centralized marketing group, which encompasses product management, field-marketing and market communications and application science. Marketing maintains value-proposition based product roadmaps, collaborates with research and development on timing and investment for new products, supports direct and distributor sales activities, sets the global pricing of our products and conceives the storylines on how to sell our products. Marketing also maintains digital presence across the web and social media, creates electronic leads and analyzes opportunities for new product portfolio extensions.

Research and Development

Our principal research and development mission is to develop products that address growth opportunities within the life science research process as well as to maintain and optimize our existing product portfolios. We maintain development staff in many of our manufacturing facilities to design and develop new products and to re-engineer existing products to bring them to the next generation. Our research and development expenses were approximately $10.8 million and $8.7 million for the years ended December 31, 2021 and 2020, respectively. We anticipate that we will continue to make investments in research and development activities as we deem appropriate. We plan to continue to pursue a balanced development portfolio strategy of originating new products from internal research and acquiring products through business and technology acquisitions.

Manufacturing

We manufacture and test the majority of our products in our principal manufacturing facilities located in the United States, Sweden, Spain and Germany. We have considerable manufacturing flexibility at our various facilities, and each facility can manufacture multiple products at the same time. We maintain in-house manufacturing expertise, technologies and resources. We seek to maintain multiple suppliers for key components that are not manufactured in-house, and while some of our products are dependent on sole-source suppliers, we have made investments in new talent in procurement and other functions to reduce exposures related to sole-source suppliers, and are accelerating these efforts given the dynamics of the global supply chain in 2021. Our manufacturing operations primarily involve assembly and testing activities along with some machine-based processes. Going forward we will continue to evaluate our manufacturing facilities and operations in order to optimize our manufacturing footprint.

See “Part I, Item 2. Properties” of this report for additional information regarding our manufacturing facilities.

Competition

The markets into which we sell our products are highly competitive, and we expect the intensity of competition to continue or increase. We compete with many companies engaged in developing and selling tools for life science research. Many of our competitors have greater financial, operational, sales and marketing resources and more experience in research and development and commercialization than we have. Moreover, our competitors may have greater name recognition than we do, and many offer discounts as a competitive tactic. These competitors and other companies may have developed or could in the future develop new technologies that compete with our products, which could render our products obsolete. We cannot provide assurance that we will be able to make the enhancements to our technologies necessary to compete successfully with newly emerging technologies. We believe that we offer one of the broadest selections of products to organizations engaged in life science research. We have numerous competitors on a product line basis. We believe that we compete favorably with our competitors on the basis of product performance, including quality, reliability, speed, technical support, price and delivery time.

We compete with several companies that provide instruments for life science research including, Lonza Group Ltd., Becton Dickinson, Eppendorf AG, Kent Scientific Corporation, Razel Scientific Instruments, Inc., Ugo Basile, Danaher Corporation, Bio-Rad Laboratories, Inc., PerkinElmer, Inc., Thermo Fisher Scientific, Inc. Notocord, Emka Technologies and TSE Systems.

We cannot forecast if or when these or other companies may develop competitive products. We expect that other products will compete with our products and potential products based on efficacy, safety, cost and intellectual property positions. While we believe that these will be the primary competitive factors, other factors include, in certain instances, availability of supply, manufacturing, marketing and sales expertise and capability.

Seasonality

Sales and earnings in our third quarter are usually flat or down from the second quarter primarily because there are a large number of holidays and vacations during such quarter, especially in Europe. Our fourth quarter revenues and earnings are often the highest in any fiscal year compared to the other three quarters, primarily because many of our customers tend to spend budgeted money before their own fiscal year ends.

Intellectual Property

To establish and protect our proprietary technologies and products, we rely on a combination of patent, copyright, trademark and trade secret laws, as well as confidentiality provisions in our contracts. Patents or patent applications cover certain of our new technologies. Most of our more mature product lines are protected by trade names and trade secrets only.

We have implemented a patent strategy designed to provide us with freedom to operate and facilitate commercialization of our current and future products. Our success depends, to a significant degree, upon our ability to develop proprietary products and technologies. We intend to continue to file patent applications as we develop new products and technologies.

Patents provide some degree of protection for our intellectual property. However, the assertion of patent protection involves complex legal and factual determinations and is therefore uncertain. The scope of any of our issued patents may not be sufficiently broad to offer meaningful protection. In addition, our issued patents or patents licensed to us may be successfully challenged, invalidated, circumvented or unenforceable so that our patent rights would not create an effective competitive barrier. Moreover, the laws of some foreign countries may protect our proprietary rights to a greater or lesser extent than the laws of the United States. In addition, the laws governing patentability and the scope of patent coverage continue to evolve, particularly in areas of interest to us. As a result, there can be no assurance that patents will be issued from any of our patent applications or from applications licensed to us. As a result of these factors, our intellectual property positions bear some degree of uncertainty.

We also rely in part on trade secret protection of our intellectual property. We attempt to protect our trade secrets by entering into confidentiality agreements with third parties, employees and consultants. Our employees and consultants also sign agreements requiring that they assign to us their interests in patents and copyrights arising from their work for us. Although many of our United States employees have signed agreements not to compete unfairly with us during their employment and after termination of their employment, through the misuse of confidential information, soliciting employees, soliciting customers and the like, the enforceability of these provisions varies from jurisdiction to jurisdiction and, in some circumstances, they may not be enforceable. In addition, it is possible that these agreements may be breached or invalidated and if so, there may not be an adequate corrective remedy available. Despite the measures we have taken to protect our intellectual property, we cannot provide assurance that third parties will not independently discover or invent competing technologies or reverse engineer our trade secrets or other technologies. Therefore, the measures we are taking to protect our proprietary rights may not be adequate.

We do not believe that our products infringe on the intellectual property rights of any third party. We cannot assure, however, that third parties will not claim such infringement by us or our licensors with respect to current or future products. We expect that product developers in our market will increasingly be subject to such claims as the number of products and competitors in our market segment grows and the product functionality in different market segments overlaps. In addition, patents on production and business methods are becoming more common and we expect that more patents will be issued in our technical field. Any such claims, with or without merit, could be time-consuming, result in costly litigation and diversion of management's attention and resources, cause product shipment delays or require us to enter into royalty or licensing agreements. Moreover, such royalty or licensing agreements, if required, may not be on terms advantageous to us, or acceptable at all, which could seriously harm our business or financial condition.

"Harvard" is a registered trademark of Harvard University. The marks "Harvard Apparatus" and "Harvard Bioscience" are being used pursuant to a license agreement entered into in December 2002 between us and Harvard University.

Government Regulation

We are not subject to direct governmental regulation other than the laws and regulations generally applicable to businesses in the domestic and foreign jurisdictions in which we operate. In particular, our current products are not subject to pre-market approval by the United States Food and Drug Administration ("FDA") for use on human clinical patients. In addition, we believe we are materially in compliance with all relevant environmental laws.

Employees

As of December 31, 2021, we employed 494 employees, which included 475 full-time employees. Some of our employees in Europe have statutory collective bargaining rights. We have never experienced a general work stoppage or strike, and management believes that our relations with our employees are good. Additional information about our employees follows:

Employees by country:

Country	Full time	Part time
United States	296	13
Germany	81	6
United Kingdom	34	-
Spain	28	-
China	17	-
Rest of World	19	-
Total	475	19

Employees by business function:

Function	Full time	Part time
Manufacturing	189	8
Sales and marketing	160	3
Research and development	66	1
General and administrative	60	7
Total	475	19

We make employment decisions without regard to age, color, national origin, citizenship status, physical or mental disability, race, religion, creed, gender, sex, sexual orientation, gender identity and/or expression, genetic information, marital status, status with regard to public assistance, veteran and military status or any other characteristic protected by federal, state or local law. We take steps to employ and advance in employment qualified protected veterans and qualified individuals with disabilities.

Every effort is made to ensure that our policies regarding hiring, salary administration, promotion, and transfer are based solely on job requirements, job performance, and job-related criteria.

Geographic Area

Financial information regarding geographic areas in which we operate is provided in Note 15 to the Consolidated Financial Statements included in "Part IV, Item 15. Exhibits, Financial Statement Schedules" of this report.

Available Information and Website

Our website address is www.harvardbioscience.com. Our Annual Report on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K, and exhibits and amendments to those reports filed or furnished with the Securities and Exchange Commission pursuant to Section 13(a) of the Exchange Act are available for review on our website and the Securities and Exchange Commission's website at www.sec.gov. Any such materials that we file with, or furnish to, the SEC in the future will be available on our website as soon as reasonably practicable after they are electronically filed with, or furnished to, the SEC. The information on our website is not incorporated by reference into this Annual Report on Form 10-K.

Item 1A. ***Risk Factors.***

The following factors should be reviewed carefully, in conjunction with the other information contained in this Annual Report on Form 10-K. As previously discussed, our actual results could differ materially from our forward-looking statements. Our business faces a variety of risks. These risks include those described below and may include additional risks and uncertainties not presently known to us or that we currently deem immaterial. If any of the events or circumstances described in the following risk factors occur, our business operations, performance and financial condition could be adversely affected, and the trading price of our common stock could decline.

Risks Related to Our Industry

The life sciences industry is very competitive.

We expect to encounter increased competition from both established and development-stage companies that continually enter the market. These include companies developing and marketing life science instruments, systems and lab consumables, health care companies that manufacture laboratory-based tests and analyzers, diagnostic and pharmaceutical companies, analytical instrument companies, and companies developing life science or drug discovery technologies. Currently, our principal competition comes from established companies that provide products that perform many of the same functions for which we market our products. Many of our competitors have substantially greater financial, operational, marketing and technical resources than we do. Moreover, these competitors may offer broader product lines and tactical discounts and may have greater name recognition. In addition, we may face competition from new entrants into the field. We may not have the financial resources, technical expertise or marketing, distribution or support capabilities to compete successfully in the future. In addition, we face changing customer preferences and requirements, including increased customer demand for more environmentally friendly products.

The life sciences industry is also subject to rapid technological change and discovery. The development of new or improved products, processes or technologies by other companies may render our products or proposed products obsolete or less competitive. In some instances, our competitors may develop or market products that are more effective or commercially attractive than our current or future products. To meet the evolving needs of customers, we must continually enhance our current products and develop and introduce new products. However, we may experience difficulties that may delay or prevent the successful development, introduction and marketing of new products or product enhancements. In addition, our product lines are based on complex technologies that are subject to change as new technologies are developed and introduced in the marketplace. We may have difficulty in keeping abreast of the changes affecting each of the different markets we serve or intend to serve. Our failure to develop and introduce products in a timely manner in response to changing technology, market demands, or the requirements of our customers could cause our product sales to decline, and we could experience significant losses.

We offer, and plan to continue to offer, a broad range of products and have incurred, and expect to continue to incur, substantial expenses for development of new products and enhancements to our existing products. The speed of technological change in our market may prevent us from being able to successfully market some or all of our products for the length of time required to recover development costs. Failure to recover the development costs of one or more products or product lines could decrease our profitability or cause us to experience significant losses.

A portion of our revenues are derived from customers from the pharmaceutical and biotechnology industries and are subject to risks faced by those industries. Such risks may adversely affect our financial results.

We derive a significant portion of our revenues from pharmaceutical and biotechnology companies. We expect that pharmaceutical and biotechnology companies will continue to be a significant source of our revenues for the foreseeable future, including in our Cellular and Molecular Technologies and Preclinical product families. As a result, we are subject to risks and uncertainties that affect the pharmaceutical and biotechnology industries, such as government regulation, ongoing consolidation, uncertainty of technological change, and reductions and delays in research and development expenditures by companies in these industries.

In particular, the biotechnology industry is largely dependent on raising capital to fund its operations. If biotechnology companies that are our customers are unable to obtain the financing necessary to purchase our products, our business and results of operations could be adversely affected. In addition, we are dependent, both directly and indirectly, upon general health care spending patterns, particularly in the research and development budgets of the pharmaceutical and biotechnology industries, as well as upon the financial condition and purchasing patterns of various governments and government agencies. As it relates to both the biotechnology and pharmaceutical industries, many companies have significant patents that have expired or are about to expire, which could result in reduced revenues for those companies. If pharmaceutical or biotechnology companies that are our customers suffer reduced revenues as a result of these patent expirations, they may be unable to purchase our products, and our business and results of operations could be adversely affected.

Changes in governmental regulations may reduce demand for our products, adversely impact our revenues, or increase our expenses.

We operate in many markets in which we and our customers must comply with federal, state, local and international regulations. We develop, configure and market our products to meet customer needs created by, and in compliance with, those regulations. These requirements include, among other things, regulations regarding manufacturing practices, product labeling, and advertising and post marketing reporting. We must incur expense and spend time and effort to ensure compliance with these complex regulations. Possible regulatory actions for non-compliance could include warning letters, fines, damages, injunctions, civil penalties, recalls, seizures of our products, and criminal prosecution. These actions could result in, among other things, substantial modifications to our business practices and operations; refunds, recalls, or seizures of our products; a total or partial shutdown of production in one or more of our facilities while we or our suppliers remedy the alleged violation; and withdrawals or suspensions of current products from the market. Any of these events could disrupt our business and have a material adverse effect on our revenues, profitability and financial condition.

Risks Related to Our Business

Reductions in customers' research budgets or government funding may adversely affect our business.

Many of our customers are universities, government research laboratories, private foundations and other institutions who are dependent on grants from government agencies, such as the National Institutes of Health ("NIH") in the United States, for funding. These customers represent a significant source of our revenue. Research and development spending by our customers may fluctuate based on spending priorities and general economic conditions. The level of government funding for research and development is unpredictable. In the past, NIH grants have been frozen or otherwise made unavailable for extended periods or directed to certain products. Reductions or delay in governmental spending could cause customers to delay or forego purchases of our products. If government funding necessary for purchase of our products were to decrease, our business and results of operations could be materially, adversely affected. Spending by some of these customers fluctuates based on budget allocations and the timely passage of the annual federal budget. An impasse in federal government budget decisions could lead to substantial delays or reductions in federal spending.

Our business is subject to economic, political and other risks associated with international revenues and operations.

We manufacture and sell our products worldwide and as a result, our business is subject to risks associated with doing business internationally. A substantial amount of our revenues is derived from international operations, and we anticipate that a significant portion of our sales will continue to come from outside the United States in the future. We anticipate that revenues from international operations will likely continue to increase as a result of our efforts to expand our business in markets abroad. In addition, a number of our manufacturing facilities and suppliers are located outside the United States.

Our foreign operations subject us to certain risks, including: effects of fluctuations in foreign currency exchange rates; the impact of local economic conditions; local product preferences and seasonality and product requirements; local difficulty to effectively establish and expand our business and operations in international markets; disruptions of capital and trading markets; restrictions and potentially negative tax implications of transfer of capital across borders; differing labor regulations; other factors beyond our control, including potential political instability, terrorism, acts of war, natural disasters and diseases, including the coronavirus discussed below; unexpected changes and increased enforcement of regulatory requirements and various state, federal and international, intellectual property, environmental, antitrust, anti-corruption, fraud and abuse (including anti-kickback and false claims laws) and employment laws; interruption to transportation flows for delivery of parts to us and finished goods to our customers; and laws and regulations on foreign investment in the United States under the jurisdiction of the Committee on Foreign Investment in the United States, or CFIUS, and other agencies, including the Foreign Investment Risk Review Modernization Act, or FIRRMA, adopted in August 2018.

A small percentage of our products are subject to export control regulations administered by the U.S. Department of the Treasury's Office of Foreign Assets Control ("OFAC") and by the Export Administration Regulations administered by the U.S. Department of Commerce's Bureau of Industry and Security ("BIS"). Based on the nature of the product, its ultimate end use and country of destination, we are sometimes subject to foreign assets control and economic sanctions regulations administered by OFAC, which restrict or prohibit our ability to transact with certain foreign countries, certain individuals and entities identified on the Treasury Department's "Denied Parties List." Under the OFAC regulations, the sale or transfer of certain equipment to a location outside the United States may require prior approval in the form of an export license issued by the BIS or the U.S. Department of State's Directorate of Defense Trade Controls. Some potential international transactions may also be restricted or prohibited based on the location, nationality or identity of the potential end user, customer or other parties to the transaction or may require prior authorization in the form of an OFAC license. Any delay in obtaining required governmental approvals could affect our ability to conclude a sale or timely commence a project, and the failure to comply with all such controls could result in criminal and/or civil penalties. These international transactions may otherwise be subject to tariffs and import/export restrictions from the United States or other governments.

Our overall success as a global business depends, in part, upon our ability to succeed in differing economic, social and political conditions. In order to continue to succeed in our international sales strategy, we must continue developing and implementing policies and strategies that are effective in each location where we do business, which could negatively affect our profitability.

We have substantial debt and other financial obligations, and we may incur even more debt. Any failure to meet our debt and other financial obligations or maintain compliance with related covenants could harm our business, financial condition and results of operations.

Our credit agreement provides for a term loan of $40.0 million and a $25.0 million senior revolving credit facility (collectively, the "Credit Agreement") and will mature on December 22, 2025. As of December 31, 2021, we had outstanding borrowings of $49.5 million under the Credit Agreement.

Pursuant to the terms of the Credit Agreement, we are subject to various covenants, including negative covenants that restrict our ability to engage in certain transactions, which may limit our ability to respond to changing business and economic conditions. Such negative covenants include, among other things, limitations on our ability and the ability of our subsidiaries to:

- incur debt,
- incur liens,
- make investments (including acquisitions),
- sell assets, and
- pay dividends on our capital stock.

In addition, the Credit Agreement contains certain financial covenants, including a maximum consolidated net leverage ratio and a minimum consolidated fixed charge coverage ratio, each of which will be tested at the end of each fiscal quarter of the Company.

If we are not in compliance with certain of these covenants, in addition to other actions our lenders may require, the amounts outstanding under the Credit Agreement may become immediately due and payable. This immediate payment may negatively impact our financial condition. In addition, any failure to make scheduled payments of interest and principal on our outstanding indebtedness would likely harm our ability to incur additional indebtedness on acceptable terms. Our cash flow and capital resources may be insufficient to pay interest and principal on our debt in the future. If that should occur, our capital raising or debt restructuring measures may be unsuccessful or inadequate to meet our scheduled debt service obligations, which could cause us to default on our obligations and further impair our liquidity.

Further, based upon our actual performance levels, our covenants relating to leverage and fixed charges could limit our ability to incur additional debt, which could hinder our ability to execute our current business strategy.

Our ability to make scheduled payments on our debt and other financial obligations and comply with financial covenants depends on our financial and operating performance. Our financial and operating performance will continue to be subject to prevailing economic conditions and to financial, business and other factors, some of which are beyond our control. Failure within any applicable grace or cure periods to may such payments, comply with the financial covenants, or any other non-financial or restrictive covenant, would create a default under our Credit Agreement. Our cash flow and existing capital resources may be insufficient to repay our debt at maturity, in which such case prior thereto we would have to extend such maturity date, or otherwise repay, refinance and or restructure the obligations under the Credit Agreement, including with proceeds from the sale of assets, and additional equity or debt capital. If we are unsuccessful in obtaining such extension, or entering into such repayment, refinance or restructure prior to maturity, or any other default existed under the Credit Agreement, our lenders could accelerate the indebtedness under the Credit Agreement, foreclose against their collateral or seek other remedies, which would jeopardize our ability to continue our current operations.

Ethical concerns surrounding the use of our products and misunderstanding of the nature of our business could adversely affect our ability to develop and sell our existing products and new products.

Some of our products may be used in areas of research involving animal research and other techniques presently being explored in the life science industry. These techniques have drawn negative attention in the public forum. Government authorities may regulate or prohibit any of these activities. Additionally, the public may disfavor or reject these activities.

If we are not able to manage our growth, our operating profits may be adversely impacted.

Our success will depend on the expansion of our operations through organic growth, and we may execute acquisitions in the future to augment this growth. Effective growth management will place increased demands on our management team, operational and financial resources and expertise. To manage growth, we must optimize our operational, financial and management processes and systems, and information technology infrastructure and hire and train additional qualified personnel. While we are currently in the process of evaluating potential improvements to and consolidation of many of our processes and systems, we may not be able to implement these changes in an efficient or timely manner. Failure to manage our growth effectively, including failure to improve our systems and processes timely or efficiently, could impair our ability to generate revenues or could cause our expenses to increase more rapidly than revenues, resulting in operating losses or reduced profitability.

Foreign currency exchange rate fluctuations may have a negative impact on our reported earnings.

We are subject to the risks of fluctuating foreign currency exchange rates, which could have an adverse effect on the sales price of our products in foreign markets, as well as the costs and expenses of our foreign subsidiaries. A substantial amount of our revenues is derived from international operations, and we anticipate that a significant portion of revenues will continue to come from outside the United States in the future. As a result, currency fluctuations among the United States dollar, British pound, euro and the other currencies in which we do business have caused and will continue to cause foreign currency translation and transaction gains and losses. We have not used forward exchange contracts to hedge our foreign currency exposures. We attempt to manage foreign currency risk through the matching of assets and liabilities. In the future, we may undertake to manage foreign currency risk through hedging methods, including foreign currency contracts. We recognize foreign currency gains or losses arising from our operations in the period incurred. We cannot guarantee that we will be successful in managing foreign currency risk or in predicting the effects of exchange rate fluctuations upon our future operating results because of the number of currencies involved, the variability of currency exposure and the potential volatility of currency exchange rates. We cannot predict with any certainty changes in foreign currency exchange rates or the degree to which we can address these risks.

Failure or inadequacy of our information technology infrastructure or software could adversely affect our day-to-day operations and decision-making processes and have an adverse effect on our performance.

We depend on accurate and timely information and numerical data from key software applications to aid our day-to-day business, financial reporting and decision-making and, in many cases, proprietary and custom-designed software is necessary to operate our business.

Disruption caused by the failure of these systems, the underlying equipment, or communication networks could delay or otherwise adversely impact day-to-day business and decision making, could make it impossible for us to operate critical equipment, and could have an adverse effect on our performance. Although we maintain disaster recovery procedures for our critical systems, our disaster recovery plans may not fully mitigate the effect of any such disruption. Disruptions could be caused by a variety of factors, such as catastrophic events or weather, power outages, or cyber-attacks on our systems by outside parties.

We review our information technology (IT) systems regularly to assess and implement opportunities to improve or upgrade our enterprise resource planning (ERP) or other information systems required to operate our business effectively. Our ERP systems are critical to our ability to accurately maintain books and records, record transactions, provide important information to our management and prepare our financial statements. The implementation of any IT systems, including ERP systems has required in the past, and may continue to require, the investment of significant financial and human resources. In addition, we may not be able to successfully complete the implementation of the ERP systems without experiencing difficulties. Any disruptions, delays or deficiencies in the design and implementation of any IT system, including ERP systems could adversely affect our ability to process orders, ship products, provide services and customer support, send invoices and track payments, fulfill contractual obligations or otherwise operate our business.

An information security incident, including a cybersecurity breach, could have a negative impact to our business or reputation.

To meet business objectives, we rely on both internal IT systems and networks, and those of third parties and their vendors, to process and store sensitive data, including confidential research, business plans, financial information, intellectual property, and personal data that may be subject to legal protection. The extensive information security and cybersecurity threats, which affect companies globally, pose a risk to the security and availability of these IT systems and networks, and the confidentiality, integrity, and availability of our sensitive data. We continually assess these threats and make investments to increase internal protection, detection, and response capabilities, as well as ensure our third-party providers have required capabilities and controls, to address this risk. To date, we have not experienced any material impact to the business or operations resulting from information or cybersecurity attacks; however, because of the frequently changing attack techniques, along with the increased volume and sophistication of the attacks, there is the potential for us to be adversely impacted. This impact could result in reputational, competitive, operational or other business harm as well as financial costs and regulatory action. Additionally, the California Consumer Privacy Act of 2018 (the “CCPA”), which became effective on January 1, 2020, provides private rights of action for data breaches and requires companies that process information on California residents to make new disclosures to consumers about their data collection, use and sharing practices and allow consumers to opt out of certain data sharing with third parties. Compliance with the CCPA and other current and future applicable privacy, cybersecurity and related laws can be costly and time-consuming. Significant capital investments and other expenditures could also be required to remedy cybersecurity problems and prevent future breaches, including costs associated with additional security technologies, personnel, experts and credit monitoring services for those whose data has been breached. These costs, which could be material, could adversely impact our results of operations in the period in which they are incurred and may not meaningfully limit the success of future attempts to breach our information technology systems.

We may incur additional restructuring costs or not realize the expected benefits of our initiatives to reduce operating expenses in the future.

We may not be able to implement all of the actions that we intend to take in the restructuring of our operations, and we may not be able to fully realize the expected benefits from such realignment and restructuring plans or other similar restructurings in the future. In addition, we may incur additional restructuring costs in implementing such realignment and restructuring plans or other similar future plans in excess of our expectations. The implementation of our restructuring efforts, including the reduction of our workforce, may not improve our operational and cost structure or result in greater efficiency of our organization; and we may not be able to support sustainable revenue growth and profitability following such restructurings.

We may incur a variety of costs in connection with acquisitions we may seek to consummate in the future, and we may never realize the anticipated benefits of our acquisitions due in part to difficulties integrating the businesses, operations and product lines.

Our business strategy has historically included the acquisition of businesses, technologies, services or products that we believe are a strategic fit with our business. If we were to undertake future acquisitions, the process of integrating the acquired business, technology, service and/or product(s) may result in unforeseen operating difficulties and expenditures and potentially absorb significant management attention that would otherwise be available for ongoing development of our business. Moreover, we may fail to realize the anticipated benefits of an acquisition as rapidly as expected, or at all. Such transactions are inherently risky, and any such recent or future acquisitions could reduce stockholders' ownership, cause us to incur debt, expose us to future liabilities and result in amortization expenses related to intangible assets with definite lives, which may adversely impact our ability to undertake future acquisitions on substantially similar terms. We may also incur significant expenditures in anticipation of an acquisition that is never realized.

Our ability to achieve the benefits of acquisitions depends in part on the integration and leveraging of technology, operations, sales and marketing channels and personnel. Integration is a complex, time-consuming and expensive process and may disrupt our business if not completed in a timely and efficient manner. We may have difficulty successfully integrating acquired businesses, and their domestic and foreign operations or product lines, and as a result, we may not realize any of the anticipated benefits of the acquisitions we make. We cannot assure that our growth rate will equal the growth rates that have been experienced by us, and these other acquired companies, respectively, operating as separate companies in the past.

Failure to raise additional capital or generate the significant capital necessary to implement our acquisition strategy, expand our operations and invest in new products could reduce our ability to compete and result in less revenues.

We anticipate that our financial resources, which include available cash, cash generated from operations, and debt and equity capacity, will be sufficient to finance operations and capital expenditures for at least the next twelve months. However, this expectation is premised on the current operating plan, which may change as a result of many factors, including market acceptance of new products and future opportunities with collaborators. Consequently, we may need additional funding sooner than anticipated. In addition, our borrowings under the Credit Agreement may not be sufficient to fund our acquisition strategy. In such case, our inability to raise sufficient capital on favorable terms and in a timely manner (if at all) could seriously harm our business, product development, and acquisition efforts. In addition, our Credit Agreement contains various negative covenants that, among other things, restrict our ability to incur additional indebtedness and make acquisitions for aggregate consideration in excess of $5.0 million. If future financing is not available or is not available on acceptable terms, we may have to alter our operations or change our business strategy. We cannot assure you that the capital required to fund operations, or our acquisition strategy will be available in the future.

If we fail to retain key personnel and hire, train and retain qualified employees, we may not be able to compete effectively, which could result in reduced revenue or increased costs.

Our success is highly dependent on the continued services of key management, technical and scientific personnel. Our management and other employees may voluntarily terminate their employment at any time upon short notice. The loss of the services of any member of the senior management team, including the Chief Executive Officer, James Green; the Chief Financial Officer, Michael Rossi; or any of the managerial, technical or scientific staff may significantly delay or prevent the achievement of product development, our growth strategies and other business objectives. Our future success will also depend on our ability to identify, recruit and retain additional qualified scientific, technical and managerial personnel. We operate in several geographic locations where labor markets are particularly competitive, including the Boston, Massachusetts and Minneapolis, Minnesota metropolitan areas, England, and Germany where demand for personnel with these skills is extremely high and is likely to remain high. Additionally, the COVID-19 pandemic and other macroeconomic factors have exacerbated these challenges, contributed to a sustained labor shortage, and increased turnover rates. As a result, competition for qualified personnel is intense, particularly in the areas of general management, finance, information technology, engineering and science, and the process of hiring suitably qualified personnel is often lengthy and expensive, and may become more expensive in the future. If we are unable to hire and retain a sufficient number of qualified employees, our ability to conduct and expand our business could be seriously reduced.

Our success will depend partly on our ability to operate without infringing on or misappropriating the intellectual property rights of others.

We may be sued for infringing on the intellectual property rights of others, including the patent rights, trademarks and trade names of third parties. Intellectual property litigation is costly, and the outcome is uncertain. If we do not prevail in any intellectual property litigation, in addition to any damages we might have to pay, we could be required to stop the infringing activity, or obtain a license to or design around the intellectual property in question. If we are unable to obtain a required license on acceptable terms, or are unable to design around any third-party patent, we may be unable to sell some of our products and services, which could result in reduced revenue.

As a result of our spin-off of Harvard Apparatus Regenerative Technology, Inc., now known as Biostage, together with certain related transactions, third parties may seek to hold us responsible for Biostage's liabilities, including liabilities that Biostage has assumed from us.

Third parties may continue to seek to hold us responsible for Biostage's liabilities, including any of the liabilities that Biostage agreed to retain or assume in connection with the separation of the Biostage business from our businesses, and related spin-off distribution. On April 14, 2017, representatives for the estate of an individual plaintiff filed a wrongful death complaint with the Suffolk Superior Court, in the County of Suffolk, Massachusetts (the "Court"), against us and other defendants, including Biostage, as well as another third party. The complaint seeks payment for an unspecified amount of damages and alleges that the plaintiff sustained terminal injuries allegedly caused by products, including one synthetic trachea scaffold and two bioreactors, provided by certain of the named defendants and utilized in connection with surgeries performed by third parties in Europe in 2012 and 2013.

On September 15, 2021, Biostage's products liability insurance carrier, which insures us as an additional insured and which had appointed defense counsel and had been defending both Biostage and us on this case, notified us and Biostage that it was denying coverage under the applicable policy for the lawsuit and would no longer be providing a defense to us or Biostage with respect thereto, or covering related legal expenses incurred after September 30, 2021. The insurance carrier also filed a corresponding complaint for declaratory judgment with the Court asking the Court to declare that said insurance provider is not required to defend, indemnify or provide coverage to us or Biostage with respect to the lawsuit.

On January 24, 2022, the Superior Court, Suffolk County, granted our and Biostage's jointly filed motion for a preliminary injunction against the insurance carrier requiring that it continue to pay legal expenses incurred by Biostage and us in connection with the underlying lawsuit during the pendency of the insurance coverage lawsuit, as well as awarding reasonable attorneys' fees and costs incurred by the parties in connection with seeking the preliminary injunction. The insurance carrier has filed a notice of appeal of the preliminary injunction.

We continue to believe that the insurance carrier's grounds for denying coverage are without merit, and intend to vigorously defend against this complaint for declaratory judgment and the insurance carrier's denial of the claim and related matters in order to, among other things, restore our rights to seek insurance coverage for any damages awarded in the lawsuit. However, notwithstanding the preliminary injunction, there can be no assurance that we and Biostage will prevail in the insurance coverage litigation. As such, other than what has been ordered in the preliminary injunction, it is unclear at this point the full extent to which our liability insurance coverage will reimburse us for all or any portion of any defense costs or damages incurred in connection with the underlying case.

Additionally, while there can be no assurance of prevailing, we intend to defend the plaintiff's claims against us in the underlying case vigorously. A trial date has been set for October 2022 and the parties are currently preparing for trial. If we lose on the merits and a jury awards damages, we do not know the exact amount of compensatory and, potentially, punitive damages that could be awarded, but the amounts could be substantial. Further, while Biostage has agreed to indemnify us for claims and losses relating to certain liabilities that it has assumed from us, including liabilities in connection with the sale of Biostage's products and other liabilities related to the operation of Biostage's business, we cannot be assured that Biostage will have the ability to indemnify us against the liabilities we may incur in this lawsuit, in particular due to Biostage's overall financial condition. If Biostage is unable to satisfy its obligations under its indemnity to us and if the insurance carrier does not fund the defense of the case, we may have to fund the entire defense of the case and satisfy the liabilities in this lawsuit, which could have an adverse impact on our financial condition or cash flows.

Risks Related to Our Common Stock

If we raise additional funds through the sale of equity or convertible debt or equity-linked securities, existing percentages of ownership in our common stock will be reduced and these transactions may dilute the value of our outstanding common stock.

We may raise additional funds through the sale of equity or convertible debt or equity-linked securities to repay our existing indebtedness, implement our acquisition strategy, expand our operations and/or invest in new products. If we so raise additional funds through such sales, existing percentages of ownership in our common stock will be reduced and these transactions may dilute the value of our outstanding common stock. We may issue securities that have rights, preferences and privileges senior to our common stock. If we raise additional funds through collaborations or licensing arrangements, we may relinquish rights to certain of our technologies or products, or grant licenses to third parties on terms that are unfavorable.

Our stock price has fluctuated in the past and could experience substantial declines in the future.

The market price of our common stock has experienced significant fluctuations and may become volatile and could decline in the future, perhaps substantially, in response to various factors including, but not limited to:

- volatility of the financial markets;
- uncertainty regarding the prospects of the domestic and foreign economies;
- technological innovations by competitors or in competing technologies;
- revenues and operating results fluctuating or failing to meet the expectations of management, securities analysts, or investors in any quarter;
- comments of securities analysts and mistakes by or misinterpretation of comments from analysts, downward revisions in securities analysts' estimates or management guidance;
- investment banks and securities analysts becoming subject to lawsuits that may adversely affect the perception of the market;
- conditions or trends in the biotechnology and pharmaceutical industries;
- announcements of significant acquisitions or financings or strategic partnerships;
- non-compliance with the internal control standards pursuant to the Sarbanes-Oxley Act of 2002; and
- a decrease in the demand for our common stock.

In addition, public stock markets have experienced extreme price and trading volatility. The stock market and the Nasdaq Global Market in general, and the biotechnology industry and small cap markets in particular, have experienced significant price and volume fluctuations that at times may have been unrelated or disproportionate to the operating performance of those companies. These broad market and industry factors may further harm the market price of our common stock, regardless of our operating performance. In the past, securities class action litigation has often been instituted following periods of volatility in the market price of a company's securities. A securities class action suit against us could result in substantial costs, potential liabilities and the diversion of management's attention and resources.

General Risks

We are currently operating in a period of economic uncertainty and capital markets disruption, which has been significantly impacted by geopolitical instability due to the ongoing military conflict between Russia and Ukraine. Our business, financial condition and results of operations may be materially adversely affected by any negative impact on the global economy and capital markets resulting from the conflict in Ukraine or any other geopolitical tensions.

U.S. and global markets are experiencing volatility and disruption following the escalation of geopolitical tensions and the start of the military conflict between Russia and Ukraine. On February 24, 2022, a full-scale military invasion of Ukraine by Russian troops was reported. Although the length and impact of the ongoing military conflict is highly unpredictable, the conflict in Ukraine could lead to market disruptions, including significant volatility in commodity prices, credit and capital markets, as well as supply chain interruptions. We are continuing to monitor the situation in Ukraine and globally and assessing its potential impact on our business.

Additionally, Russia's prior annexation of Crimea, recent recognition of two separatist republics in the Donetsk and Luhansk regions of Ukraine and subsequent military interventions in Ukraine have led to sanctions and other penalties being levied by the United States, European Union and other countries against Russia, Belarus, the Crimea Region of Ukraine, the so-called Donetsk People's Republic, and the so-called Luhansk People's Republic, including agreement to remove certain Russian financial institutions from the Society for Worldwide Interbank Financial Telecommunication ("SWIFT") payment system. Additional potential sanctions and penalties have also been proposed and/or threatened. Russian military actions and the resulting sanctions could adversely affect the global economy and financial markets and lead to instability and lack of liquidity in capital markets, potentially making it more difficult for us to obtain additional funds.

Any of the abovementioned factors could affect our business, prospects, financial condition, and operating results. The extent and duration of the military action, sanctions and resulting market disruptions are impossible to predict, but could be substantial. Any such disruptions may also magnify the impact of other risks described in this Annual Report on Form 10-K.

The COVID-19 outbreak has significantly impact worldwide economic conditions and has negatively impacted our business, financial condition and results of operations.

The ongoing global outbreak of COVID-19 has caused disruptions to our business and has had a negative impact on our operations to date. Since the global outbreak of COVID-19, many of our customers, particularly academic research institutions, have reduced laboratory work which has negatively impacted, and will continue to negatively impact, our sales. While many of our customers, including academic labs, have reopened, a significant number of them remained closed or at significantly lower capacity levels through during 2021. Additionally, to ensure business continuity while maintaining a safe environment for employees aligned with guidance from government and health organizations, we transitioned a significant portion of our workforce to work-from-home while implementing social distancing requirements and other measures to allow manufacturing and other personnel essential to production to continue work within the Company's facilities. Business travel continues to be significantly reduced. While a portion of our workforce has returned to in-office work and travel is less restricted, we continue to have restrictions which represent disruptions which can impact productivity including sales and marketing activities. Accordingly, these conditions in addition to the overall impact on the global economy could continue to have a negative impact our results of operations and cash flows.

Disruptions to the global supply chain have adversely affected our financial results and cash flows.

The global supply chain experienced significant disruptions during 2021 as a result of electronic component and labor shortages and other macroeconomic factors that have emerged since the onset of the COVID-19 pandemic. As a result of these disruptions, we have experienced delays in supplier deliveries, extended lead times, and increased cost of freight, purchased materials and manufacturing labor costs. These disruptions have delayed and may continue to delay the timing of some customer orders and expected deliveries of our products. We believe that these supply chain trends will continue in 2022. If the impacts of the supply chain disruptions are more severe than we expect, it could result in longer lead times and further increased costs, all of which could materially adversely affect our business, financial condition and results of operations.

If we incur higher costs as a result of trade policies, treaties, government regulations or tariffs, we may become less profitable.

There continues to be uncertainty about the relationship between the United States and foreign countries, including with respect to trade policies, treaties, government regulations and tariffs. We are unable to predict whether or when tariffs will be imposed or the impact of any such future tariff increases.

We may be the subject of lawsuits from counterparties to acquisitions and divestitures, including an acquiring company or its stockholders, an acquired company's previous stockholders, a divested company's stockholders or our current stockholders.

We may be the subject of lawsuits from either an acquiring company or its stockholders, an acquired company's previous stockholders, a divested company's stockholders or our current stockholders. Such lawsuits could result from the actions of the acquisition or divestiture target prior to the date of the acquisition or divestiture, from the acquisition or divestiture transaction itself or from actions after the acquisition or divestiture. Defending potential lawsuits could cost us significant expense and detract management's attention from the operation of the business. Additionally, these lawsuits could result in the cancellation of or the inability to renew certain insurance coverage that would be necessary to protect our assets.

Rising commodity and precious metals costs could adversely impact our profitability.

Raw material commodities such as resins, and precious metal commodities such as platinum are subject to wide price variations. Increases in the costs of these commodities and the costs of energy, transportation and other necessary services may adversely affect our profit margins if we are unable to pass along any higher costs in the form of price increases or otherwise achieve cost efficiencies such as in manufacturing and distribution.

Provisions of Delaware law, or of our charter and bylaws may make a takeover more difficult, which could cause our stock price to decline.

Provisions in our certificate of incorporation and bylaws and in the Delaware corporate law may make it difficult and expensive for a third party to pursue a tender offer, change in control or takeover attempt, which is opposed by management and the board of directors. Public stockholders who might desire to participate in such a transaction may not have an opportunity to do so. We have a staggered board of directors that makes it difficult for stockholders to change the composition of the board of directors in any one year. These anti-takeover provisions could substantially impede the ability of public stockholders to change our management and board of directors. Such provisions may also limit the price that investors might be willing to pay for shares of our common stock in the future.

Item 1B. ***Unresolved Staff Comments.***

None.

Item 2. ***Properties.***

Our facilities perform manufacturing, research and development, sales and marketing, and administration functions. As of December 31, 2021, we leased the following principal facilities:

Location	Description of Facility	Approximate Square Footage	Expiration
Holliston, Massachusetts	Manufacturing facility and corporate headquarters	83,000	2024
New Brighton, Minnesota	Manufacturing facility	73,000	2030
Reutlingen, Germany	Manufacturing facility	23,000	2024
Barcelona, Spain	Manufacturing facility	16,000	2022-2023
March-Hugstetten, Germany	Manufacturing facility	11,000	2024

We also lease additional facilities in Cambridge, England; Kista, Sweden; Shanghai, China; St. Augustin, Germany; and Montreal, Canada. We believe our current facilities are adequate for our needs for the foreseeable future.

Item 3. ***Legal Proceedings.***

For information related to legal proceedings, see the discussion in Note 14 to the Consolidated Financial Statements included in "Part IV, Item 15. Exhibits, Financial Statement Schedules" of this report, which information is incorporated by reference into this Item 3.

Item 4. ***Mine Safety Disclosures***

Not Applicable.

PART II

Item 5. ***Market for Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities***

Market Information

Our common stock has been quoted on the Nasdaq Global Market since our initial public offering on December 7, 2000, and trades under the symbol "HBIO."

Stockholders

There were 94 holders of record of our common stock as of March 4, 2022. The number of record holders was determined from the records of our transfer agent and does not include beneficial owners of our common stock whose shares are held in the names of various security brokers, dealers, and registered clearing agencies.

Dividend Policy

We have never declared or paid cash dividends on our common stock in the past and do not intend to pay cash dividends on our common stock in the foreseeable future. Any future determination to pay cash dividends will be at the discretion of our Board of Directors and will depend on our financial condition, results of operations, capital requirements and other factors our Board of Directors deems relevant.

Item 6. ***[Reserved]***

Item 7. ***Management's Discussion and Analysis of Financial Condition and Results of Operations.***

Forward-Looking Statements

The following section of this Annual Report on Form 10-K contains statements that are not statements of historical fact and are forward-looking statements within the meaning of federal securities laws. These statements involve known and unknown risks, uncertainties and other factors that may cause our actual results, performance or achievements to be materially different from any future results, performance or achievements expressed or implied by the forward-looking statements. These statements reflect our current views with respect to future events and are based on assumptions and subject to risks and uncertainties. Factors that may cause our actual results to differ materially from those in the forward-looking statements include those factors described in "Item 1A. Risk Factors" in this Annual Report on Form 10-K. You should carefully review all of these factors, as well as the comprehensive discussion of forward-looking statements on page 1 of this Annual Report on Form 10-K.

Overview

Harvard Bioscience is a leading developer, manufacturer and seller of technologies, products and services that enable fundamental research, discovery, and preclinical testing for drug development. Our customers range from renowned academic institutions and government laboratories to the world's leading pharmaceutical, biotechnology and contract research organizations. With operations in North America, Europe, and China, we sell through a combination of direct and distribution channels to customers around the world.

Recent Developments

COVID-19

The COVID-19 pandemic has had a negative impact on our operations since its onset in March 2020. While the Company has improved revenues and operations during 2021, a higher degree of volatility and uncertainty in the global economy has been observed during this period, and with it uncertainty around economic impacts. Since the global outbreak of COVID-19, many customers, particularly academic research institutions, have reduced laboratory work which has negatively impacted, and will continue to negatively impact, our sales. While many of our customers, including academic labs, have reopened, a significant number of them remained closed or at significantly lower capacity levels during 2021. Additionally, to ensure business continuity while maintaining a safe environment for employees aligned with guidance from government and health organizations, we transitioned a significant portion of our workforce to work-from-home while implementing social distancing requirements and other measures to allow manufacturing and other personnel essential to production to continue work within our facilities. Business travel was significantly reduced during this period. While a portion of the workforce has returned to in-office work and travel is less restricted, we continue to have restrictions which represent disruptions which can impact productivity including sales and marketing activities.

The global supply chain experienced significant disruptions during 2021 due to electronic component and labor shortages and other macroeconomic factors, which have emerged since the onset of the COVID-19 pandemic, leading to increased cost of freight, purchased materials and manufacturing labor costs, while also delaying customer shipments. We believe these supply chain trends will continue through 2022. These conditions in addition to the overall impact on the global economy have negatively impacted our results of operations and cash flows.

Revenues for the years ending December 31, 2021 and 2020, were negatively impacted due to the conditions noted. If business interruptions resulting from COVID-19 were to be more prolonged or expanded in scope, our business, financial condition, results of operations and cash flows would be further negatively impacted. We will continue to actively monitor this situation and will implement actions necessary to maintain business continuity.

See Part I, Item 1. "Business–Our History and Strategy" of this report for a discussion of recent significant acquisitions, divestitures and other developments.

July 2019 Restructuring Plan

In December 2019, we implemented the July 2019 Restructuring Plan (the "Restructuring Plan") to deliver significant cost savings beginning in 2020 and to support delivery of the strategic action plan we announced in September 2019. The Restructuring Plan included consolidation of our Connecticut manufacturing plant with our existing Massachusetts site, downsizing of operations in the United Kingdom and a reduction in force across the business equal to approximately 10% of our headcount. The Restructuring Plan is expected to deliver annualized run-rate savings of $4.0 million to $5.0 million. The original initiatives under the Restructuring Plan were completed in the second half of 2020.

We continued to execute the Restructuring Plan during the COVID-19 pandemic and expanded the scope of the restructuring by realigning our organizational structure to reduce management layers and accelerated our efforts to move to a leaner organization and operation. As a result of this expanded scope, we eliminated additional headcount during 2020, and in the first quarter of 2021, communicated to employees our plan to consolidate certain engineering operations and eliminate two small facilities in Europe.

We incurred cash outlays of $9.0 million as a result of the actions taken under the Restructuring Plan and incremental cost reduction actions taken and other business improvements. The Restructuring Plan generated significant cost savings while removing waste and inefficiency and improving our overall skillset in our workforce. A portion of these savings have been reinvested in sales, marketing and other areas to support profitable growth, as well as additional labor costs added in 2021 to address the global supply chain and other macroeconomic impacts discussed throughout this MD&A.

Selected Results of Operations

Year ended December 31, 2021 compared to year ended December 31, 2020

In the table below, we provide an overview of selected operating metrics.

	Year Ended December 31,			
(dollars in thousands)	**2021**	**% of revenue**	**2020**	**% of revenue**
Revenues	$ 118,904		$ 102,100	
Gross profit	67,652	56.9%	58,041	56.8%
Sales and marketing expenses	24,642	20.7%	19,916	19.5%
General and administrative expenses	24,305	20.4%	23,509	23.0%
Research and development expenses	10,799	9.1%	8,685	8.5%
Amortization of intangible assets	5,840	4.9%	5,710	5.6%
Interest expense	1,540	1.3%	4,831	4.7%
Debt extinguishment and related costs	-	0.0%	1,876	1.8%
Income tax expense	148	0.1%	518	0.5%

Revenues

Revenues for the year ended December 31, 2021, were $118.9 million, an increase of approximately $16.8 million, or 16.5%, compared to revenues of $102.1 million for the year ended December 31, 2020. As a result of the COVID-19 pandemic, many customers, particularly academic research institutions, had been unable to maintain laboratory work resulting in a large number of academic labs were closed during 2020. Revenue improved significantly in 2021 due to academic labs reopening. We believe that academic lab activity was below pre-COVID levels for the majority of 2021, but activity was significantly higher than prior year. Revenue also increased due to improved sales of products from our Preclinical product family associated with improved sales processes, market growth in Asia, and product enhancements released in 2020.

Gross profit

Gross profit increased $9.7 million, or 16.6%, to $67.7 million for the year ended December 31, 2021, compared with $58.0 million for the year ended December 31, 2020, due primarily to the increase in revenue noted. Gross margin improved due to improved product mix and higher volume but was adversely impacted by higher supply chain, logistics and manufacturing labor costs . The global supply chain has experienced significant disruptions during 2021 due to electronic component and labor shortages and other macroeconomic factors, leading to the increased cost noted. We believe these supply chain trends will continue in 2022.

Sales and marketing expenses

Sales and marketing expenses increased $4.7 million, or 23.7%, to $24.6 million for the year ended December 31, 2021, compared to $19.9 million during the same period in 2020. The increase was primarily due to investments in new marketing and sales support personnel and related costs as more of our employees returned from part-time to full-time status and higher variable sales costs associated with the increase in sales as compared to the prior period.

General and administrative expenses

General and administrative expenses were $24.3 million for the year ended December 31, 2021, an increase of $0.8 million, or 3.4%, compared with $23.5 million for the year ended December 31, 2020. The increase was due to higher compensation costs as our employees returned from part-time to full-time status and higher stock-based compensation costs which were partially offset by lower restructuring and related initiative costs as compared to the prior period.

Research and development expenses

Research and development expenses were $10.8 million for the year ended December 31, 2021, an increase of $2.1 million, or 24.3%, compared with $8.7 million for the year ended December 31, 2020. The increase was due to higher compensation costs as our employees returned from part-time to full-time status and increased project related costs aligned with our organic growth initiatives noted.

Amortization of intangible assets

Amortization of intangible asset expenses was $5.8 million for the year ended December 31, 2021, compared to $5.7 million for the year ended December 31, 2020.

Interest expense

Interest expense was $1.5 million for the year ended December 31, 2021, a decrease of $3.3 million, or 68.1%, compared with $4.8 million for the year ended December 31, 2020. The decrease was primarily due to lower interest rates under our new Credit Agreement entered into on December 22, 2020.

Debt extinguishment and related costs

On December 22, 2020, we entered into the Credit Agreement which replaced our prior credit facility. In connection with our entry into the Credit Agreement, we paid $0.6 million in debt extinguishment costs, wrote off $0.8 million of unamortized debt issuance costs, and paid $0.5 million to terminate our interest rate swap agreements.

Income tax expense

Income tax expense for the year ended December 31, 2021 and 2020 was $0.1 million and $0.5 million, respectively. The effective tax rates for the year ended December 31, 2021 and 2020 were (106)% and (7)%, respectively. The difference between our effective tax rates in 2021 and 2020 compared to the U.S. statutory tax rate of 21% is primarily due to changes in valuation allowances associated with our assessment of the likelihood of the recoverability of our deferred tax assets. We currently have valuation allowances against substantially all of our net operating loss carryforwards and tax credit carryforwards.

Liquidity and Capital Resources

Our primary sources of liquidity are cash and cash equivalents, internally generated cash flow from operations and our revolving credit facility. Our expected cash outlays relate primarily to cash payments due under our Credit Agreement described below as well as capital expenditures, severance and other payments associated with ongoing restructuring and cost reduction initiatives.

On December 22, 2020, we entered into the Credit Agreement that provides for a term loan of $40.0 million and a $25.0 million senior revolving credit facility (including a $10.0 million sub-facility for the issuance of letters of credit and a $10.0 million swingline loan sub-facility). Our borrowings under the Credit Agreement mature on December 22, 2025.

The Credit Agreement replaced the prior credit facility which consisted of a revolving credit facility and a term loan and was scheduled to expire on January 31, 2023. In connection with entering into the Credit Agreement, we paid off the prior credit facility with borrowings under the Credit Agreement and incurred $1.9 million in fees and expenses.

As of December 31, 2021, we held cash and cash equivalents of $7.8 million, compared with $8.3 million at December 31, 2020. Borrowings outstanding was $49.4 million as of both December 31, 2021 and December 31, 2020. Total debt, net of cash and cash equivalents, was $41.6 million at December 31, 2021, compared to $41.1 million at December 31, 2020. As of December 31, 2021 and December 31, 2020, cash held by our foreign subsidiaries was $2.8 million and $2.5 million.

Condensed Consolidated Cash Flow Statements

	Year Ended December 31,	
(in thousands)	**2021**	**2020**
Cash provided by operating activities	$ 1,262	$ 9,331
Cash used in investing activities	(1,345)	(1,402)
Cash used in financing activities	(252)	(7,967)
Effect of exchange rate changes on cash	(161)	20
Decrease in cash and cash equivalents	$ (496)	$ (18)

Cash provided by operations was $1.3 million and $9.3 million for the year ended December 31, 2021 and 2020, respectively. Cash flow from operations for year ended December 31, 2021, was lower than the prior year period due to higher levels of working capital. During 2021 we experienced longer supplier lead times due to global supply chain disruptions as well as an overall increase in customer demand and orders. Accordingly, inventory purchasing has increased to ensure continuity of supply for order fulfillment. Also, accounts receivable has increased due to revenue growth. Cash flow from operations for the year ended December 31, 2020, was positively impacted by reductions in working capital due to lower revenue and management efforts to offset the initial significant negative impacts that the COVID-19 pandemic had on revenue.

Cash used in investing activities was $1.3 million and $1.4 million for the years ended December 31, 2021 and 2020, respectively, and consisted primarily of capital expenditures in manufacturing and information technology infrastructure.

Cash used in financing activities was $0.3 million for the year ended December 31, 2021. During this period, we made term loan installments payments under the Credit Agreement of $2.0 million, with net borrowings of $2.0 million under the revolving facility. We also received proceeds of $3.3 million from the exercise of stock options and employee stock purchases and paid $3.5 million for taxes related to net share settlement of equity awards.

Cash used in financing activities was $8.0 million for the year ended December 31, 2020. During this period, we made net payments to reduce total debt by $5.6 million. Prior to entering the Credit Agreement, we made payments under the prior credit facility of $11.1 million to reduce term loan borrowings, with net borrowings of $2.8 million under the revolving facility. At the closing of the Credit Agreement, we repaid in full the prior credit facility, which included $43.9 million of term loan borrowings and $2.8 million of outstanding revolver borrowings. Under the Credit Agreement, we borrowed $49.4 million, consisting of a $40.0 million term loan and $9.4 million drawn on the revolving loan. We paid $1.9 million of costs associated with the debt refinancing. We also received proceeds of $0.7 million from the exercise of stock options and employee stock purchases and paid $1.1 million for taxes related to net share settlement of equity awards.

Borrowing

On December 22, 2020, we entered into the Credit Agreement which provides for a term loan of $40.0 million and a $25.0 million senior revolving credit facility (including a $10.0 million sub-facility for the issuance of letters of credit and a $ 10.0 million swingline loan sub-facility). Obligations under the Credit Agreement are secured by substantially all of our assets and are guaranteed by certain of our direct, domestic wholly-owned subsidiaries. We are compliant with all covenants under the Credit Agreement as of December 31, 2021. Our borrowings under the Credit Agreement will mature on December 22, 2025. See Note 11 to the Consolidated Financial Statements for a detailed discussion regarding our Credit Agreement.

We had borrowings of $49.4 million outstanding as of both December 31, 2021 and December 31, 2020. Available borrowing capacity under the revolving line of credit was $13.6 million as of December 31, 2021. As of December 31, 2021 and 2020, the interest rate on our borrowings was 3.0% and 3.25%, respectively.

Based on our current operating plans, we expect that our available cash, cash generated from current operations and debt capacity will be sufficient to finance current operations, any costs associated with restructuring activities and capital expenditures for at least the next 12 months. This assessment includes consideration of our best estimates of the impact of the COVID-19 pandemic on our financial results described above. Our forecast of the period of time through which our financial resources will be adequate to support our operations is a forward-looking statement that involves risks and uncertainties, and actual results could vary as a result of a number of factors.

Impact of Foreign Currencies

Our international operations in some instances operate in a natural hedge as we sell our products in many countries and a substantial portion of our revenues, costs and expenses are denominated in foreign currencies, primarily the British pound, the euro, the Canadian dollar and the Swedish krona.

During the year ended December 31, 2021, changes in foreign currency exchange rates resulted in a favorable translation effect on our consolidated revenues and on our consolidated net loss. Changes in foreign currency exchange rates resulted in a favorable effect on revenues of approximately $1.7 million and an unfavorable effect on expenses of approximately $1.8 million.

The translation of foreign currency into U.S. dollars included as a component of comprehensive income during the year ended December 31, 2021 resulted in a loss of approximately $2.4 million, compared to a gain of $1.7 million for the year ended December 31, 2020.

In addition, the currency exchange rate fluctuations included as a component of net loss resulted in approximately $(0.1) million and $(0.5) million in currency loss during the year ended December 31, 2021 and 2020, respectively.

Recent Accounting Pronouncements

For information on recent accounting pronouncements impacting our business, see "Recent Accounting Pronouncements" included in Note 2 to the Consolidated Financial Statements included in "Part IV, Item 15. Exhibits, Financial Statement Schedules" of this report.

Critical Accounting Policies and Estimates

The discussion and analysis of our financial condition and results of operations are based upon our consolidated financial statements, which have been prepared in accordance with accounting principles generally accepted in the United States. The preparation of these financial statements requires us to make estimates and judgments that affect the reported amounts of assets, liabilities, revenue and expenses, and related disclosure of contingent assets and liabilities. On an ongoing basis, we evaluate our estimates, including those related to revenue recognition, investments, income taxes, litigation and other contingencies. We base our estimates on historical experience and on various other assumptions that are believed to be 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. Actual results may differ from these estimates under different assumptions or conditions.

We believe the following are the more significant judgments and estimates used in the preparation of our consolidated financial statements.

Intangible Assets

Intangible assets are comprised of existing technology, customer contracts and contractual relationships, and other definite-lived and indefinite-lived intangible assets. Identifiable intangible assets resulting from the acquisitions of entities accounted for using the purchase method of accounting are estimated by management based on the fair value of assets received. Identifiable definite-lived intangible assets are being amortized over the period of estimated benefit using the straight-line method and estimated useful lives ranging from four to fifteen years.

We amortize definite-lived assets over their estimated useful lives. We evaluate definite-lived and indefinite-lived assets for impairment whenever events or changes in circumstances indicate the carrying value of an asset may not be recoverable. The carrying value is not recoverable if it exceeds the undiscounted cash flows resulting from the use of the asset and its eventual disposition. Our estimates of future cash flows attributable to our assets require significant judgment based on our historical and anticipated results and are subject to many factors. Factors we consider important which could trigger an impairment review include significant negative industry or economic trends, significant loss of clients, and significant changes in the manner of our use of the acquired assets or the strategy for our overall business.

When we determine that the carrying value of the assets may not be recoverable based upon the existence of one or more of the above indicators of impairment, we measure the potential impairment based on a projected discounted cash flow method using a discount rate determined by our management to be commensurate with the risk inherent in our current business model. An impairment loss is recognized only if the carrying amount of the asset is not recoverable and exceeds its fair value. Different assumptions and judgments could materially affect the calculation of the fair value of our assets.

Income Taxes and Valuation Allowance

We are subject to income taxes in the U.S. and numerous foreign jurisdictions. Our annual tax rate is based on income, statutory tax rates, tax reserve changes and tax planning opportunities available to us in the various jurisdictions in which we operate. Significant judgment is required in determining the annual tax rate and in evaluating our tax positions. We regularly assess the likelihood of tax adjustments in each of the tax jurisdictions in which we have operations and account for the related financial statement implications. We have established tax reserves that we believe are appropriate given the possibility of tax adjustments. Determining the appropriate level of tax reserves requires judgment regarding the uncertain application of tax laws. Reserves are adjusted when information becomes available or when an event occurs indicating a change in the reserve is appropriate. Changes in tax reserves could have a material impact on our financial condition or results of operations.

Significant judgment is also required in determining the amount of deferred tax assets that will ultimately be realized and corresponding deferred tax asset valuation allowance. When estimating the necessary valuation allowance, we consider all available evidence for each jurisdiction including historical operating results, estimates of future taxable income and the feasibility of ongoing tax planning strategies. If new information becomes available that would alter our estimate of the amount of deferred tax assets that will ultimately be realized, we adjust the valuation allowance through income tax expense. Changes in the deferred tax asset valuation allowance could have a material impact on our financial condition or results of operations.

Excess and Obsolete Inventory

Inventories are priced at the lower of cost (first-in, first-out method) or net realizable value. When necessary, the write-down of inventory to its net realizable value is recorded for obsolete or slow-moving inventory based on assumptions about future demand and marketability of products, the impact of new product introductions and specific identification of items, such as product discontinuance or engineering/material changes. In the future if these factors are less favorable than our projected expectations additional inventory write-downs may be required.

Item 7A. ***Quantitative and Qualitative Disclosures about Market Risk.***

Not Applicable.

Item 8. ***Financial Statements and Supplementary Data.***

The information required by this item is contained in the financial statements referenced in "Part IV, Item 15. Exhibits, Financial Statement Schedules" of this report, which financial statements are appended to this report. An index of those financial statements is found on page F-1.

Item 9. ***Changes in and Disagreements with Accountants on Accounting and Financial Disclosure.***

None.

Item 9A. ***Controls and Procedures.***

This Report includes the certifications of our Chief Executive Officer and Chief Financial Officer required by Rule 13a-14 of the Securities Exchange Act of 1934, as amended (the "Exchange Act"). See Exhibits 31.1 and 31.2. This Item 9A includes information concerning the controls and control evaluations referred to in those certifications.

(a) Evaluation of Disclosure Controls and Procedures

Disclosure controls and procedures refer to controls and other procedures designed to ensure that information required to be disclosed in the reports we file or submit under the Exchange Act is recorded, processed, summarized and reported, within the time periods specified in the rules and forms of the U.S. Securities and Exchange Commission. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by us in our reports that we file or submit under the Exchange Act is accumulated and communicated to our management, including our Chief Executive Officer and Chief Financial Officer, as appropriate to allow timely decisions regarding our required disclosure. In designing and evaluating our disclosure controls and procedures, our management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving the desired control objectives, and management was required to apply its judgment in evaluating and implementing possible controls and procedures.

We carried out an evaluation, under the supervision and with the participation our Chief Executive Officer and Chief Financial Officer, of the effectiveness of the design and operation of our disclosure controls and procedures (as defined in Rules 13a-15(e) and 15d-15(e) under the Exchange Act) as of the end of the period covered in this Report. Based upon the evaluation described above, our Chief Executive Officer and Chief Financial Officer have concluded that they believe that our disclosure controls and procedures were effective, as of December 31, 2021, in providing reasonable assurance that information required to be disclosed by us in the reports that we file or submit under the Exchange Act is accumulated and communicated to our management, including our Chief Executive Officer and Chief Financial Officer, to allow timely decisions regarding required disclosures, and is recorded, processed, summarized and reported within the time periods specified in the Securities and Exchange Commission's rules and forms.

(b) Management's Report on Internal Control Over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting (as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act). Our internal control over financial reporting is a process designed by and under the supervision of our Chief Executive Officer and Chief Financial Officer and effected by our management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of consolidated financial statements for external purposes in accordance with generally accepted accounting principles. Our internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect transactions and dispositions of assets, (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of consolidated financial statements for external purposes in accordance with generally accepted accounting principles, (3) provide reasonable assurance that receipts and expenditures are being made only in accordance with authorizations of management and directors, and (4) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of assets that could have a material effect on the consolidated financial statements.

Because of inherent limitations, internal control over financial reporting may not prevent or detect misstatements. It is a process that involves human diligence and compliance and is therefore subject to human error and misjudgment. In general, evaluations of effectiveness for future periods are subject to risk as controls may become inadequate due to changes in conditions or the degree of compliance with key processes or procedures could deteriorate.

Our management evaluated the effectiveness of our internal control over financial reporting as of December 31, 2021 using the criteria set forth in Internal Control – Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). As a result of that evaluation, management has concluded that our internal control over financial reporting was effective as of December 31, 2021.

The effectiveness of our internal control over financial reporting as of December 31, 2021 has also been audited by Grant Thornton LLP, our independent registered public accounting firm, as stated in their report, which is included below in Item 9A(e).

(c) Changes in Internal Controls Over Financial Reporting

There has been no change in the Company's internal control over financial reporting as of December 31, 2021, that has materially affected, or is reasonably likely to materially affect, the Company's internal control over financial reporting. We continue to monitor the impact of the COVID-19 pandemic and, despite many of our employees working remotely, have not experienced any changes that materially affected, or are reasonably likely to materially affect, our internal control over financial reporting.

(d) Inherent Limitations on Effectiveness of Controls

The design of any system of control is based upon certain assumptions about the likelihood of future events, and there can be no assurance that any design will succeed in achieving its stated objectives under all future events, no matter how remote, that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may not deteriorate. Because of their inherent limitations, systems of control may not prevent or detect all misstatements. Accordingly, even effective systems of control can provide only reasonable assurance of achieving their control objectives.

(e) Report of Independent Registered Public Accounting Firm

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

Board of Directors and Shareholders
Harvard Bioscience, Inc.

Opinion on internal control over financial reporting

We have audited the internal control over financial reporting of Harvard Bioscience, Inc. (a Delaware corporation) and subsidiaries (the "Company") as of December 31, 2021, based on criteria established in the 2013 *Internal Control—Integrated Framework* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"). In our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2021, based on criteria established in the 2013 *Internal Control—Integrated Framework* issued by COSO.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) ("PCAOB"), the consolidated financial statements of the Company as of and for the year ended December 31, 2021, and our report dated March 11, 2022 expressed an unqualified opinion on those financial statements.

Basis for opinion

The Company's management is responsible for maintaining effective internal control over financial reporting and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management's Report on Internal Control over Financial Reporting ("Management's Report") . Our responsibility is to express an opinion on the Company's internal control over financial reporting based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects. Our audit included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, testing and evaluating the design and operating effectiveness of internal control based on the assessed risk, and performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

Definition and limitations of internal control over financial reporting

A company's internal control over financial reporting is a process designed 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. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

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

/s/ GRANT THORNTON LLP

Boston, Massachusetts
March 11, 2022

Item 9B. ***Other Information.***

None.

Item 9C. ***Disclosure Regarding Foreign Jurisdictions that Prevent Inspections.***

Not applicable.

PART III

Item 10. ***Directors, Executive Officers and Corporate Governance.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act, in connection with our 2022 Annual Meeting of Stockholders.

Item 11. ***Executive Compensation.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2022 Annual Meeting of Stockholders.

Item 12. ***Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2022 Annual Meeting of Stockholders.

Item 13. ***Certain Relationships and Related Transactions, and Director Independence.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2022 Annual Meeting of Stockholders.

Item 14. ***Principal Accounting Fees and Services.***

Incorporated by reference to our definitive Proxy Statement to be filed pursuant to Regulation 14A under the Exchange Act in connection with our 2022 Annual Meeting of Stockholders.

PART IV

Item 15. ***Exhibits, Financial Statement Schedules.***

The following documents are filed as part of this Annual Report on Form 10-K or incorporated by reference as indicated:

(a) *Financial Statements, Schedules, and Exhibits.* We have listed our consolidated financial statements filed as part of this annual report in the index to consolidated financial statements on page F-1.

(b) *Exhibits.* We have listed the exhibits filed as part of this annual report in the accompanying exhibit index, which follows the signature page to this annual report

(c) Financial Statement Schedules. We have omitted all financial statement schedules because they are not applicable or not required or because we have included the necessary information in our consolidated financial statements or related notes.

Item 16. ***Form 10-K Summary.***

None.

INDEX TO CONSOLIDATED FINANCIAL STATEMENTS
HARVARD BIOSCIENCE, INC.

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

Board of Directors and Shareholders
Harvard Bioscience Inc.

Opinion on the financial statements
We have audited the accompanying consolidated balance sheets of Harvard Bioscience Inc. (a Delaware corporation) and subsidiaries (the "Company") as of December 31, 2021 and 2020, the related consolidated statements of operations, comprehensive income (loss), stockholders' equity, and cash flows for each of the two years in the period ended December 31, 2021, and the related notes (collectively referred to as the "financial statements"). In our opinion, the financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2021 and 2020, and the results of its operations and its cash flows for each of the two years in the period ended December 31, 2021, in conformity with accounting principles generally accepted in the United States of America.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) ("PCAOB"), the Company's internal control over financial reporting as of December 31, 2021, based on criteria established in the 2013 *Internal Control—Integrated Framework* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"), and our report dated March 11, 2022 expressed an unqualified opinion.

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

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

Critical audit matters
Critical audit matters are matters arising from the current period audit of the financial statements that were communicated or required to be communicated to the audit committee and that: (1) relate to accounts or disclosures that are material to the financial statements and (2) involved our especially challenging, subjective, or complex judgments. We determined that there are no critical audit matters.

/s/ GRANT THORNTON LLP
We have served as the Company's auditor since 2017.

Boston, Massachusetts
March 11, 2022

HARVARD BIOSCIENCE, INC.
CONSOLIDATED BALANCE SHEETS
(In thousands, except share and per share data)

	December 31, 2021	December 31, 2020
Assets		
Current assets:		
Cash and cash equivalents	$ 7,821	$ 8,317
Accounts receivable, net	21,834	17,766
Inventories	27,587	22,262
Other current assets	4,341	3,355
Total current assets	61,583	51,700
Property, plant and equipment, net	3,415	3,960
Operating lease right-of-use assets	6,897	7,761
Goodwill	57,689	58,590
Intangible assets, net	27,385	33,151
Other long-term assets	5,375	1,092
Total assets	$ 162,344	$ 156,254
Liabilities and Stockholders' Equity		
Current liabilities:		
Current portion of long-term debt	$ 3,235	$ 1,721
Current portion of operating lease liabilities	2,142	2,111
Accounts payable	4,911	5,972
Deferred revenue	4,266	3,771
Other current liabilities	10,762	7,478
Total current liabilities	25,316	21,053
Long-term debt	45,095	46,286
Deferred income tax liabilities	1,558	1,899
Operating lease liabilities	6,488	7,481
Other long-term liabilities	486	2,854
Total liabilities	78,943	79,573
Commitments and contingencies - Note 14		
Stockholders' equity:		
Preferred stock, par value $0.01 per share, 5,000,000 shares authorized	-	-
Common stock, par value $0.01 per share, 80,000,000 shares authorized: 41,142,876 shares issued and outstanding at December 31, 2021; 47,152,587 shares issued and 39,407,080 shares outstanding at December 31, 2020	452	444
Additional paid-in-capital	225,650	232,357
Accumulated deficit	(132,674)	(132,386)
Accumulated other comprehensive loss	(10,027)	(13,066)
Treasury stock at cost, -0- and 7,745,507 common shares, respectively	-	(10,668)
Total stockholders' equity	83,401	76,681
Total liabilities and stockholders' equity	$ 162,344	$ 156,254

See accompanying notes to consolidated financial statements.

HARVARD BIOSCIENCE, INC.
CONSOLIDATED STATEMENTS OF OPERATIONS
(In thousands, except per share data)

	Year Ended December 31,	
	2021	**2020**
Revenues	$ 118,904	$ 102,100
Cost of revenues	51,252	44,059
Gross profit	67,652	58,041
Sales and marketing expenses	24,642	19,916
General and administrative expenses	24,305	23,509
Research and development expenses	10,799	8,685
Amortization of intangible assets	5,840	5,710
Total operating expenses	65,586	57,820
Operating income	2,066	221
Other expense:		
Interest expense	(1,540)	(4,831)
Debt extinguishment and related costs	-	(1,876)
Other, net	(666)	(806)
Total other expense	(2,206)	(7,513)
Loss before income taxes	(140)	(7,292)
Income tax expense	148	518
Net loss	$ (288)	$ (7,810)
Loss per share:		
Basic and diluted loss per common share	$ (0.01)	$ (0.20)
Weighted-average common shares:		
Basic and diluted	40,343	38,640

See accompanying notes to consolidated financial statements.

HARVARD BIOSCIENCE, INC.
CONSOLIDATED STATEMENTS OF COMPREHENSIVE INCOME (LOSS)
(In thousands)

	Year Ended December 31,	
	2021	**2020**
Net loss	$ (288)	$ (7,810)
Other comprehensive (loss) income:		
Foreign currency translation adjustments	(2,353)	1,700
Derivatives qualifying as hedges:		
Loss on derivative instruments designated and qualifying as cash flow hedges	-	(206)
Amounts reclassified from accumulated other comprehensive loss to net loss	-	809
Derivatives qualifying as hedges	-	603
Defined benefit pension plans, net of tax		
Net gain (loss), net of tax expense of $1,160 and $ -0- , respectively	4,946	(2,785)
Amounts reclassified from accumulated other comprehensive loss to net loss, net of tax expense of $105 and $-0- , respectively	446	105
Defined benefit pension plans, net of tax	5,392	(2,680)
Other comprehensive income (loss)	3,039	(377)
Comprehensive income (loss)	$ 2,751	$ (8,187)

See accompanying notes to consolidated financial statements.

HARVARD BIOSCIENCE, INC.
CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY
(In thousands)

	Number of Shares Issued	Common Stock	Additional Paid-in Capital	Accumulated Deficit	Accumulated Other Comprehensive Loss	Treasury Stock	Total Stockholders' Equity
Balance at December 31, 2019	45,934	$ 438	$ 229,189	$ (124,576)	$ (12,689)	$ (10,668)	$ 81,694
Stock option exercises	254	4	318	-	-	-	322
Stock purchase plan	126	2	345	-	-	-	347
Vesting of restricted stock units	1,171	-	-	-	-	-	-
Shares withheld for taxes	(332)	-	(1,142)	-	-	-	(1,142)
Stock compensation expense	-	-	3,647	-	-	-	3,647
Net loss	-	-	-	(7,810)	-	-	(7,810)
Other comprehensive loss	-	-	-	-	(377)	-	(377)
Balance at December 31, 2020	47,153	$ 444	$ 232,357	$ (132,386)	$ (13,066)	$ (10,668)	$ 76,681
Retirement of treasury stock	(7,746)	-	(10,668)	-	-	10,668	-
Stock option exercises	580	8	2,869	-	-	-	2,877
Stock purchase plan	96	-	437	-	-	-	437
Vesting of restricted stock units	1,571	-	-	-	-	-	-
Shares withheld for taxes	(511)	-	(3,514)	-	-	-	(3,514)
Stock compensation expense	-	-	4,169	-	-	-	4,169
Net loss	-	-	-	(288)	-	-	(288)
Other comprehensive income	-	-	-	-	3,039	-	3,039
Balance at December 31, 2021	41,143	$ 452	$ 225,650	$ (132,674)	$ (10,027)	$ -	$ 83,401

See accompanying notes to consolidated financial statements.

HARVARD BIOSCIENCE, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In thousands)

	Year Ended December 31,	
	2021	**2020**
Cash flows from operating activities:		
Net loss	$ (288)	$ (7,810)
Adjustments to reconcile net loss to net cash provided by operating activities:		
Depreciation	1,781	1,922
Amortization of intangible assets	5,840	5,710
Amortization of deferred financing costs	280	393
Write-off of unamortized deferred financing costs	-	787
Debt extinguishment costs	-	599
Stock-based compensation expense	4,169	3,647
Deferred income taxes and other	(330)	(23)
Changes in operating assets and liabilities:		
Accounts receivable	(4,294)	3,105
Inventories	(5,861)	413
Other assets	(439)	293
Accounts payable and accrued expenses	2,454	1,491
Deferred revenue	505	(184)
Other liabilities	(2,555)	(1,012)
Net cash provided by operating activities	1,262	9,331
Cash flows from investing activities:		
Additions to property, plant and equipment	(1,195)	(1,152)
Additions to intangible assets	(150)	(250)
Net cash used in investing activities	(1,345)	(1,402)
Cash flows from financing activities:		
Proceeds from issuance of debt	4,250	61,315
Repayments of debt	(4,200)	(66,912)
Debt issuance costs	(102)	(1,298)
Debt extinguishment costs	-	(599)
Proceeds from exercise of stock options	3,314	669
Taxes paid related to net share settlement of equity awards	(3,514)	(1,142)
Net cash used in financing activities	(252)	(7,967)
Effect of exchange rate changes on cash	(161)	20
Decrease in cash and cash equivalents	(496)	(18)
Cash and cash equivalents at beginning of period	8,317	8,335
Cash and cash equivalents at end of period	$ 7,821	$ 8,317
Supplemental disclosures of cash flow information:		
Cash paid for interest	$ 1,577	$ 4,881
Cash paid for income taxes, net of refunds	$ 577	$ 416

See accompanying notes to consolidated financial statements.

HARVARD BIOSCIENCE, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

1. Organization

Harvard Bioscience, Inc., a Delaware corporation, is a leading developer, manufacturer and seller of technologies, products and services that enable fundamental research, discovery, and preclinical testing for drug development. The Company's products and services are sold globally to customers ranging from renowned academic institutions and government laboratories to the world's leading pharmaceutical, biotechnology and contract research organizations. With operations in North America, Europe and China, the Company sells through a combination of direct and distribution channels to customers around the world.

Risks and Uncertainties

On March 11, 2020, the World Health Organization declared the outbreak of a novel coronavirus (COVID-19) as a pandemic. The COVID-19 pandemic has had a negative impact on the Company's operations to date and the future impacts of the pandemic and any resulting economic impact are largely unknown and rapidly evolving. Since the global outbreak of COVID-19, many customers, particularly academic research institutions, have reduced laboratory work which has negatively impacted, and will continue to negatively impact, the Company's sales. While many of the Company's customers, including academic labs, have reopened, a significant number of them remained closed or at significantly lower capacity levels during 2021. Additionally, to ensure business continuity while maintaining a safe environment for employees aligned with guidance from government and health organizations, the Company transitioned the majority of its workforce to work-from-home while implementing social distancing requirements and other measures in factories to allow manufacturing and other personnel essential to production to continue work within the Company's facilities. Business travel was significantly reduced during this period. While a portion of the workforce has returned to in-office work and travel is less restricted, the Company continued to have restrictions which represent disruptions which can impact productivity including sales and marketing activities.

The global supply chain experienced significant disruptions during 2021 due to electronic component and labor shortages and other macroeconomic factors which have emerged since the onset of the COVID-19 pandemic, leading to increased cost of freight, purchased materials and manufacturing labor costs, while also delaying customer shipments. Accordingly, these conditions in addition to the overall impact on the global economy have negatively impacted results of operations and cash flows.

2. Summary of Significant Accounting Policies

Principles of Consolidation

The consolidated financial statements include the accounts of Harvard Bioscience, Inc. and its wholly-owned subsidiaries. All intercompany balances and transactions have been eliminated in consolidation.

Use of Estimates

The preparation of financial statements in conformity with accounting principles generally accepted in the United States ("GAAP") requires the use of management estimates. Such estimates include the determination and establishment of certain accruals and provisions, including those for inventory excess and obsolescence, income tax and reserves for bad debts. In addition, certain estimates are required in order to determine the value of assets and liabilities associated with acquisitions, as well as the Company's defined benefit pension obligations. Estimates are also required to evaluate the value and recoverability of existing long-lived and intangible assets, including goodwill. On an ongoing basis, the Company reviews its estimates based upon currently available information. Actual results could differ materially from those estimates.

Cash and Cash Equivalents

The Company considers all highly liquid instruments with original maturities of three months or less to be cash equivalents. Cash and cash equivalents include cash on hand and amounts due from banks. The Company maintains a portion of its cash in bank deposits, which at times, may exceed federally insured limits. The Company has not experienced any losses in such accounts. The Company does not believe it is exposed to any significant risk with respect to these accounts.

Allowance for Doubtful Accounts

The allowance for doubtful accounts reflects the Company's best estimate of probable losses inherent in the accounts receivable balance. The Company determines the allowance based on considering factors such as historical experience, credit quality, known troubled accounts, historical experience, factors that may affect a customer's ability to pay and other currently available evidence.

Inventories

The Company values its inventories at the lower of the actual cost to purchase (first-in, first-out method) and/or manufacture the inventories or the net realizable value of the inventories. The Company regularly reviews inventory quantities on hand and records a provision to write down excess and obsolete inventories to its estimated net realizable value if less than cost, based primarily on historical inventory usage and estimated forecast of product demand.

Property, Plant and Equipment

Property, plant and equipment are stated at cost and depreciated using the straight-line method over the estimated useful lives of the assets as follows:

Machinery and equipment (years)	3 - 10
Computer equipment and software (years)	3 - 7
Furniture and fixtures (years)	5 - 10

Property and equipment held under capital leases and leasehold improvements are amortized using the straight-line method over the shorter of the lease term or estimated useful life of the asset.

Leases

The Company accounts for its leases in accordance with ASC 842 Leases. The Company leases office space, manufacturing facilities, automobiles and equipment. The Company concludes on whether an arrangement is a lease at inception. This determination as to whether an arrangement contains a lease is based on an assessment as to whether a contract conveys the right to the Company to control the use of identified property, plant or equipment for period of time in exchange for consideration. Leases with an initial term of 12 months or less are not recorded on the balance sheet. The Company recognizes these lease expenses on a straight-line basis over the lease term.

The Company has assessed its contracts and concluded that its leases consist of operating leases. Operating leases are included in operating lease right-of-use (ROU) assets, current portion of operating lease liabilities, and operating lease liabilities in the Company's consolidated balance sheets.

ROU assets represent the Company's right to use an underlying asset for the lease term and lease liabilities represent the Company's obligation to make lease payments arising from the lease. Operating lease ROU assets and liabilities are recognized at commencement date based on the present value of lease payments over the lease term. As most of the Company's leases do not provide an implicit rate, the Company determines an incremental borrowing rate based on the information available at commencement date in determining the present value of lease payments. The incremental borrowing rate represents a significant judgment that is based on an analysis of the Company's credit rating, country risk, treasury and corporate bond yields, as well as comparison to the Company's borrowing rate on its most recent loan. The Company uses the implicit rate when readily determinable. The Company has lease agreements with lease and non-lease components, which are generally accounted for separately.

Income Taxes

Income taxes are accounted for under the asset and liability method. Deferred tax assets and liabilities are recognized for the future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax bases. Deferred tax assets and liabilities are measured using enacted tax rates expected to be applied to taxable income in the years in which those temporary differences are expected to be recovered or settled. The effect on deferred tax assets and liabilities of a change in tax rates is recognized in income in the period that includes the enactment date.

The Company recognizes the effect of income tax positions only if those positions are more likely than not of being sustained. Recognized income tax positions are measured at the largest amount that is more than 50% likely of being realized. Changes in recognition are reflected in the period in which the judgement occurs.

The Company's policy is to account for Global Intangible Low-Taxed income (GILTI) as a period cost.

Foreign Currency Translation

The functional currency of the Company's foreign subsidiaries is generally their local currency. All assets and liabilities of its foreign subsidiaries are translated at exchange rates in effect at period-end. Income and expenses are translated at rates which approximate those in effect on the transaction dates. The resulting translation adjustment is recorded as a separate component of stockholders' equity in accumulated other comprehensive (loss) income ("AOCI") in the consolidated balance sheets. Gains and losses resulting from foreign currency transactions are included in net (loss) income.

Earnings per Share

Basic earnings per share is computed by dividing net income by the weighted average number of shares of common stock outstanding during the periods presented. The computation of diluted earnings per share is similar to the computation of basic earnings per share, except that the denominator is increased for the assumed exercise of dilutive options and other potentially dilutive securities using the treasury stock method unless the effect is antidilutive.

Comprehensive (Loss) Income

In accordance with ASC 220, the Company reports all changes in equity during a period, resulting from net (loss) income and transactions from non-owner sources, in a financial statement in the period in which they are recognized. The Company discloses comprehensive (loss) income, which encompasses net (loss) income, foreign currency translation adjustments, gains and losses on derivatives, the underfunded status of its pension plans, and pension minimum additional liability adjustments, net of tax, in the consolidated statements of comprehensive (loss) income.

Revenue Recognition

Nature of contracts and customers

The Company's contracts are primarily of short duration and are mostly based on the receipt and fulfilment of purchase orders. The purchase orders are binding and include pricing and all other relevant terms and conditions.

The Company's customers are primarily research scientists at pharmaceutical and biotechnology companies, universities, hospitals, government laboratories, including the United States National Institutes of Health (NIH) and contract research organizations. The Company also has global and regional distribution partners, and original equipment manufacturer (OEM) customers who incorporate its products into their products under their own brands.

Performance obligations

The Company's performance obligations under its revenue contracts consist of its instruments, equipment, accessories, services, maintenance and extended warranties. Equipment also includes software that functions together with the tangible equipment to deliver its essential functionality. Contracts with customers may contain multiple promises such as delivery of hardware, software, professional services or post-contract support services. These promises are accounted for as separate performance obligations if they are distinct. For contracts with customers that contain multiple performance obligations, the transaction price is allocated to the separate performance obligations based on estimated relative standalone selling price, which does not materially differ from the stated price in the contract. In general, the Company's list prices are indicative of standalone selling price.

Instruments, equipment and accessories consist of a range of products that are used in life sciences research. Revenues from the sales of these items are recognized when transfer of control of these products to the customer occurs. Transfer of control occurs when the Company has a right to payment, and the customer has legal title to the asset and the customer or their selected carrier has possession, which is typically upon shipment. Sales on these items are therefore generally recognized at a point in time.

The Company's equipment revenue also includes the sale of wireless implantable monitors that are used for life science research purposes. The Company sells these wireless implantable monitors to pharmaceutical companies, contract research organizations and academic laboratories. In addition to sales generated from new and existing customers, these implantable devices are also sold under a program called the "exchange program." Under this program, customers may return an implantable monitor to the Company after use, and if the returned monitor can be reprocessed and resold, they may, in exchange, purchase a replacement implantable monitor of the same model at a lower price than a new monitor. The implantable monitors that are returned by customers are reprocessed and made available for future sale. The initial sale of implantable monitors and subsequent sale of replacement implantable monitors are independent transactions. The Company has no obligation in connection with the initial sale to sell replacement implantable monitors at any future date under any fixed terms and may refuse returned implantable monitors that cannot be recovered or are obsolete. The Company has concluded that the offer to its customers that they may purchase a discounted product in the future is not a material right based on the applicable guidance within ASC 606.

Service revenue consists of installation, training, data analysis, and surgeries performed on research animals. Maintenance revenue consists of post-contract support provided in relation to software that is embedded within the equipment that is sold to the customer. The Company provides standard warranties that promise the customer that the product will work as promised. These standard warranties are not a separate performance obligation. Extended warranties relate to warranties that are separately priced, and purchased in addition to a standard warranty, and are therefore a separate performance obligation. The Company has made the judgment that the customer benefits as the Company performs over the period of the contract, and therefore revenues from service, maintenance and warranty contracts are recognized over time. The Company uses the input method to recognize revenue over time, based on time elapsed, which is generally on a straight-line basis over the service period. The period over which maintenance and warranty contracts is recognized is typically one year. The period over which service revenue is recognized is generally less than one month.

For sales for which transfer of control occurs upon shipment, the Company accounts for shipping and handling costs as fulfilment costs. As such, the Company records the amounts billed to the customer for shipping costs as revenue and the costs within cost of revenues upon shipment. For sales, for which control transfers to customers after shipment, the Company has elected to account for shipping and handling as activities to fulfill the promise to transfer the goods to the customer. The Company therefore accrues for the costs of shipping undelivered items in the period of shipment.

Revenues expected to be recognized related to remaining performance obligations are generally expected to be recognized in one year or less, as the majority of the Company's contracts have a term of less than one year.

Variable Consideration

The nature of the Company's contracts gives rise to certain types of variable consideration, including in limited cases volume and payment discounts. The Company analyzes sales that could include variable consideration and estimates the expected or most likely amount of revenue after returns, trade-ins, discounts, rebates, credits, and incentives. Product returns are estimated and accrued for, based on historical information. In making these estimates, the Company considers whether the amount of variable consideration is constrained and is included in revenue only to the extent that it is probable that a significant reversal of the revenue recognized will not occur when the uncertainty associated with the variable consideration is subsequently resolved. Variable consideration, and its impact on the Company's revenue recognition, was not material in any of the periods presented.

The Company's payment terms are generally from zero to sixty days from the time of invoicing, which generally occurs at the time of shipment or prior to services being performed. Payment terms vary by the type of its customers and the products or services offered.

Sales taxes, value added taxes, and certain excise taxes collected from customers and remitted to governmental authorities are accounted for on a net basis and are therefore excluded from revenues.

Deferred revenue

The Company records deferred revenue when cash is collected from customers prior to satisfaction of the Company's performance obligation to the customer. Deferred revenue consists of amounts deferred related to service contracts and revenue deferred as a result of payments received in advance from customers. Deferred revenue is generally expected to be recognized within one year.

The amounts included in deferred revenue from advanced payments relate to amounts that are prepaid for wireless implantable monitors under the exchange program. The Company has made the judgment that these payments do not represent a significant financing component as the customer can exercise their discretion as to when they can obtain the products that they have made a prepayment for.

Advanced payments received from customers are recorded as a liability, and revenue is recognized when the Company's performance obligations are completed. Performance obligations are completed when the product is shipped or delivered to the customer, or at the end of the exchange program if goods are not acquired prior to the termination of the contract period.

Disaggregation of revenue

Refer to Note 12 for revenue disaggregated by type as well as further information about the deferred revenue balances and to Note 15 for revenue disaggregated by geographic region.

Valuation of Identifiable Intangible Assets Acquired in Business Combinations

The determination of the fair value of intangible assets, which represents a significant portion of the purchase price in the Company's acquisitions, requires the use of significant judgment with regard to (i) the fair value; and (ii) whether such intangibles are amortizable or not amortizable and, if the former, the period and the method by which the intangibles asset will be amortized. The Company estimates the fair value of acquisition-related intangible assets principally based on projections of discounted cash flows that will arise from identifiable assets of acquired businesses. Amortizable intangible assets include existing technology, trade names, distribution agreements, customer relationships and patents, and are amortized on a straight-line basis over their estimated useful lives.

Goodwill and Other Intangible Assets

Goodwill and unamortizable intangible assets acquired in a business combination and determined to have an indefinite useful life are not amortized, but instead are tested for impairment annually or more frequently if events or changes in circumstances indicate that the asset might be impaired, in accordance with the provisions of ASC 350, "Intangibles—Goodwill and Other."

For the purpose of its goodwill analysis, the Company has one reporting unit. The Company conducts its annual impairment analysis in the fourth quarter of the fiscal year and more frequently if there is an indicator of impairment. The Company assesses qualitative factors of the reporting unit to determine whether it is more likely than not that the fair value of the reporting unit is less than its carrying value. If the qualitative assessment indicates a potential impairment, a quantitative analysis is performed. The Company compares the fair value of the reporting unit with its carrying amount. The Company estimates fair value using under the income approach using the discounted cash flows model, which indicates the fair value of the reporting unit based on the present value of the cash flows that the Company expects the reporting unit to generate in the future. The Company's significant estimates in the discounted cash flows model include weighted average cost of capital, long-term rate of growth and profitability of the reporting unit's business, and working capital effects. If the carrying amount of a reporting unit exceeds its fair value, goodwill is impaired, and the Company would recognize a loss equal to the excess. For indefinite-lived intangible assets if the carrying value exceeds the fair value of the asset, the Company would write down the indefinite-lived intangible asset to fair value. At December 31, 2021, the Company concluded that none of its goodwill was impaired.

The Company evaluates indefinite-lived intangible assets for impairment annually and when events occur, or circumstances change that may reduce the fair value of the asset below its carrying amount. Events or circumstances that might require an interim evaluation include unexpected adverse business conditions, economic factors, unanticipated technological changes or competitive activities, loss of key personnel and acts by governments and courts.

Impairment of Long-Lived Assets

The Company assesses recoverability of its long-lived assets that are held for use, such as property, plant and equipment and amortizable intangible assets in accordance with ASC 360, "Property, Plant and Equipment" when events or changes in circumstances indicate that the carrying amount of an asset or asset group may not be recoverable. Recoverability of assets or an asset group to be held and used is measured by a comparison of the carrying amount of an asset or asset group to estimated undiscounted future cash flows expected to be generated by the asset or the asset group. Cash flow projections are based on trends of historical performance and management's estimate of future performance. If the carrying amount of the asset or asset group exceeds the estimated future cash flows, an impairment charge is recognized by the amount by which the carrying amount of the asset or asset group exceeds its estimated fair value. For the year ended December 31, 2021, the Company concluded that none of its long-lived assets were impaired.

Derivatives

The Company monitors interest rate risk attributable to both its outstanding and forecasted debt obligations and may use interest-rate-related derivative instruments to manage its exposure related to changes in interest rates on its variable-rate debt instruments. The Company does not enter into derivative instruments for any purpose other than cash flow hedging. The Company does not speculate using derivative instruments. The Company recognizes all derivative instruments as either assets or liabilities in the balance sheet at their respective fair values. For derivatives designated in hedging relationships, changes in the fair value are either offset through earnings against the change in fair value of the hedged item attributable to the risk being hedged or recognized in AOCI, to the extent the derivative is effective at offsetting the changes in cash flows being hedged until the hedged item affects earnings.

Fair Value of Financial Instruments

The carrying values of the Company's cash and cash equivalents, trade accounts receivable and trade accounts payable and short-term debt approximate their fair values because of the short maturities of those instruments. The fair value of the Company's long-term debt approximates its carrying value and is based on the amount of future cash flows associated with the debt discounted using current borrowing rates for similar debt instruments of comparable maturity.

Financial reporting standards define a fair value hierarchy that consists of three levels:

§ Level 1 includes instruments for which quoted prices in active markets for identical assets or liabilities accessible to the Company at the measurement date.

§ Level 2 includes instruments for which the valuations are based on quoted prices for similar assets or liabilities, quoted prices in markets that are not active, or other inputs that are observable or can be corroborated by observable data for substantially the full term of the assets or liabilities.

§ Level 3 includes valuations based on inputs that are unobservable and significant to the overall fair value measurement.

Stock-based Compensation

The Company accounts for stock-based payment awards in accordance with the provisions of ASC 718, "Compensation—Stock Compensation", which requires it to recognize compensation expense for all stock-based payment awards made to employees and directors including stock options, restricted stock units, and restricted stock units with a market condition issued under the Company's 2021 Incentive Plan (the "2021 Incentive Plan") and the Fourth Amended and Restated 2000 Stock Option and Incentive Plan (the "2000 Incentive Plan" and together with 2021 Incentive Plan, the "Incentive Plans") as well as employee stock purchases ("employee stock purchases") related to its Employee Stock Purchase Plan (as amended, the "ESPP"). The Company issues new shares from its registered but unissued stock pool to satisfy stock option exercises and vesting of the restricted stock units.

Stock-based compensation expense recognized is based on the value of the portion of stock-based payment awards that is ultimately expected to vest. The Company values stock-based payment awards, except restricted stock units at grant date using the Black-Scholes option-pricing model. The Company values restricted stock units with a market condition using a Monte-Carlo valuation simulation. The determination of fair value of stock-based payment awards on the date of grant using an option-pricing model or Monte-Carlo valuation simulation is affected by the Company's stock price as well as assumptions regarding certain variables. These variables include, but are not limited to, the Company's expected stock price volatility over the term of the awards and actual and projected stock option exercise behaviors.

The fair value of restricted stock units is based on the market price of the Company's stock on the date of grant and are recorded as compensation expense on a straight-line basis over the applicable service period, which ranges from one to four years.

Recent Accounting Pronouncements

Accounting Pronouncements Adopted

In December 2019, the Financial Accounting Standards Board (FASB) issued Accounting Standards Update (ASU) 2019-12, *Income Taxes (Topic 740): Simplifying the Accounting for Income Taxes* (ASU 2019-12), which enhances and simplifies various aspects of the income tax accounting guidance related to intra-period tax allocation, interim period accounting for enacted changes in tax law, and the year-to-date loss limitation in interim period tax accounting. ASU 2019-12 also amends other aspects of the guidance to reduce complexity in certain areas. ASU 2019-12 was effective for the Company on January 1, 2021. The adoption of this accounting guidance did not have a material impact on the Company's consolidated financial statements.

Accounting Pronouncements to be Adopted

In November 2021, the FASB issued ASU 2021-10, *Government Assistance (Topic 832), Disclosures by Business Entities About Government Assistance* (ASU 2021-10), which requires entities to provide disclosures on material government assistance transactions for annual reporting periods. The disclosures include information around the nature of the assistance, the related accounting policies used to account for government assistance, the effect of government assistance on the entity's financial statements, and any significant terms and conditions of the agreements, including commitments and contingencies. The new standard impacts footnote disclosures and is effective for the Company's December 31, 2022 annual financial statements. The Company is currently evaluating the potential impact of adopting ASU 2021-10 will have on its consolidated financial statements.

In January 2017, the FASB issued ASU 2017-04, *Intangibles—Goodwill and Other (Topic 350): Simplifying the Test for Goodwill Impairment* (ASU 2017-04), which eliminates the performance of Step 2 from the goodwill impairment test. In performing its annual or interim impairment testing, an entity will instead compare the fair value of the reporting unit with its carrying amount and recognize any impairment charge for the amount by which the carrying amount exceeds the reporting unit's fair value. Additionally, an entity should consider income tax effects from any tax-deductible goodwill on the carrying amount of the reporting unit when measuring the goodwill impairment loss. ASU 2017-04 is effective for the Company for fiscal years beginning after December 15, 2022. The Company is currently evaluating the potential impact of adopting ASU 2017-04 will have on its consolidated financial statements.

In September 2016, the FASB issued ASU No. 2016-13, *Financial Instruments—Credit Losses (Topic 326): Measurement of Credit Losses on Financial Instruments (ASU 2016-13)*, which amends the impairment model by requiring entities to use a forward-looking approach based on expected losses rather than incurred losses to estimate credit losses on certain types of financial instruments, including trade receivables. This may result in the earlier recognition of allowances for losses. The FASB issued several ASUs after ASU 2016-13 to clarify implementation guidance and to provide transition relief for certain entities. ASU 2016-13 is effective for the Company for fiscal years beginning after December 15, 2022, with early adoption permitted. The Company is currently evaluating the impact that adopting ASU 2016-13 and related amendments will have on its consolidated financial position, results of operations and cash flows.

3. Accumulated Other Comprehensive Loss

Changes in the components of accumulated other comprehensive loss, net of tax, for the years ended December 31, 2021 and 2020, respectively, are as follows:

(in thousands)	Foreign currency translation adjustments	Derivatives qualifying as hedges	Defined benefit pension plans	Total
Balance at December 31, 2019	$ (13,173)	$ (603)	$ 1,087	$ (12,689)
Other comprehensive income (loss) before reclassifications	1,700	(206)	(2,785)	(1,291)
Amounts reclassified from AOCI	-	809	105	914
Net other comprehensive (loss) income	1,700	603	(2,680)	(377)
Balance at December 31, 2020	$ (11,473)	$ -	$ (1,593)	$ (13,066)
Other comprehensive income (loss) before reclassifications	(2,353)	-	4,946	2,593
Amounts reclassified from AOCI	-	-	446	446
Net other comprehensive (loss) income	(2,353)	-	5,392	3,039
Balance at December 31, 2021	$ (13,826)	$ -	$ 3,799	$ (10,027)

4. Goodwill and Intangible Assets

The change in the carrying amount of goodwill for the year ended December 31, 2021 and 2020 are as follows:

	December 31,	
(in thousands)	2021	2020
Balance beginning of year	$ 58,590	$ 57,381
Effect of change in currency translation	(901)	1,209
Balance at end of year	$ 57,689	$ 58,590

Identifiable intangible assets at December 31, 2021 and 2020 consist of the following:

		December 31,					
		2021			2020		
(in thousands)	Average		Accumulated			Accumulated	
Amortizable intangible assets:	Life*	Gross	Amortization	Net	Gross	Amortization	Net
Distribution agreements/customer relationships	7.9	$ 17,689	$ (8,675)	$ 9,014	$ 18,237	$ (7,746)	$ 10,491
Existing technology	4.2	38,707	(23,962)	14,745	38,761	(20,674)	18,087
Trade names and patents	4.5	8,496	(5,108)	3,388	8,681	(4,362)	4,319
Total amortizable intangible assets		$ 64,892	$ (37,745)	$ 27,147	$ 65,679	$ (32,782)	$ 32,897
Indefinite-lived intangible assets:				238			254
Total intangible assets				$ 27,385			$ 33,151

* Weighted average life in years as of December 31, 2021

Intangible asset amortization expense was $5.8 million and $5.7 million of the years ended December 31, 2021 and 2020, respectively. Estimated amortization expense of existing amortizable intangible assets for each of the five succeeding years and thereafter is as follows:

Year Ending December 31,	Amortization Expense
(in thousands)	
2022	$ 5,766
2023	5,661
2024	5,359
2025	4,262
2026	2,452
Thereafter	3,647
Total	$ 27,147

5. Balance Sheet Information

The following tables provide details of selected balance sheet items as of the periods indicated:

Inventories:	December 31,	
(in thousands)	**2021**	**2020**
Finished goods	$ 5,646	$ 4,938
Work in process	3,410	3,513
Raw materials	18,531	13,811
Total	$ 27,587	$ 22,262

Property, Plant and Equipment:	December 31,	
(in thousands)	**2021**	**2020**
Machinery and equipment	$ 7,698	$ 7,450
Computer equipment and software	6,269	9,114
Leasehold improvements	2,560	2,540
Furniture and fixtures	1,296	1,353
Automobiles	41	100
	17,864	20,557
Less: accumulated depreciation	(14,449)	(16,597)
Property, plant and equipment, net	$ 3,415	$ 3,960

During the year ended December 31, 2021, the Company removed approximately $3.7 million of fully depreciated property and equipment from its fixed asset records.

Other Current Liabilities:	December 31,	
(in thousands)	**2021**	**2020**
Compensation	$ 6,048	3,715
Professional fees	480	432
Warranty costs	240	185
Customer related costs	2,265	1,093
Accrued income taxes	224	286
Other	1,505	1,767
Total	$ 10,762	$ 7,478

6. Restructuring and Other Exit Costs

On an ongoing basis, the Company reviews the global economy, the healthcare industry, and the markets in which it competes to identify operational efficiencies, enhance commercial capabilities and align its cost base and infrastructure with customer needs and its strategic plans. In order to realize these opportunities, the Company undertakes activities from time to time to transform its business. A portion of these transformation activities are considered restructuring costs under *ASC 420 – Exit or Disposal Cost Obligations* and are discussed below.

During 2019, the Company initiated a restructuring program to improve operational efficiency and reduce costs which entailed consolidating and downsizing several sites and headcount reductions in Europe and North America. The Company incurred approximately $4.7 million of costs under this program which was completed in 2021.

The following table summarizes the activity for accrued restructuring liability for the years ended December 31, 2021 and 2020:

(in thousands)	Severance	Other	Total
Balance at December 31, 2019	$ 364	$ 4	$ 368
Restructuring and other exit costs	1,625	408	2,033
Non-cash charges	-	(168)	(168)
Cash payments	(1,719)	(226)	(1,945)
Balance at December 31, 2020	$ 270	$ 18	$ 288
Restructuring and other exit costs	1,174	101	1,275
Non-cash charges	-	(46)	(46)
Cash payments	(1,444)	(73)	(1,517)
Balance at December 31, 2021	$ -	$ -	$ -

Substantially all of these restructuring costs have been included as a component of general and administrative expenses.

7. Related Party Transactions

In connection with the 2014 acquisitions of Multi Channel Systems MCS GmbH (“MCS”), the Company entered into a facility lease agreement with the former principal owner of this company who became an employee of the Company at the time of the acquisition and subsequently retired in 2021. The MCS lease agreement expires on December 31, 2024. Pursuant to this lease agreement, the Company made rent payments of approximately $0.3 million for each of the years ended December 31, 2021 and 2020.

8. Employee Benefit Plans

Employee Retirement Savings Plans

The Company sponsors various qualified employee retirement savings plans and makes discretionary contributions to match a certain portion of employee contributions. For the years ended December 31, 2021 and 2020, the Company contributed $1.0 million and $0.9 million, respectively, to these plans.

Employee Pension Plans

The Company’s subsidiary in the United Kingdom, Biochrom Limited maintains contributory, defined benefit pension plans for its employees. In 2014, these defined benefit pension plans were closed to new employees, as well as closed to the future accrual of benefits for existing employees. The provisions of ASC 715-20 require that the funded status of the pension plans be recognized in Company’s balance sheet. ASC 715-20 does not change the measurement or income statement recognition of these plans, although it does require that plan assets and benefit obligations be measured as of the balance sheet date. The Company has historically measured the plan assets and benefit obligations as of the balance sheet date.

The components of the Company's net period benefit expense (credit) were as follows:

(in thousands)	Year Ended December 31, 2021	2020
Interest cost	$ 358	$ 391
Expected return on plan assets	(675)	(733)
Net amortization loss	551	105
Recognition of net loss due to settlements	115	22
Net periodic benefit cost (credit)	$ 349	$ (215)

The funded status of the Company's defined benefit pension plans and the amount recognized in the consolidated balance sheets at December 31, 2021 and 2020 is as follows:

(in thousands)	December 31, 2021	2020
Change in benefit obligation:		
Balance at beginning of year	$ 25,519	$ 20,027
Interest cost	358	391
Actuarial (gain) loss	(2,440)	4,814
Settlements due to transfers paid	(198)	(205)
Benefits paid	(498)	(476)
Currency translation adjustment	(179)	968
Balance at end of year	$ 22,562	$ 25,519

Changes in the actuarial loss disclosed above are primarily the result of changes in the discount rate and inflation assumptions due to underlying market conditions.

(in thousands)	December 31, 2021	2020
Change in fair value of plan assets:		
Balance at beginning of year	$ 23,926	$ 21,114
Actual return on plan assets	3,354	1,690
Employer contributions	1,042	901
Settlement due to transfers paid	(270)	(159)
Benefits paid	(498)	(476)
Currency translation adjustment	(302)	856
Balance at end of year	$ 27,252	$ 23,926

(in thousands)	December 31, 2021	2020
Benefit obligation	$ 22,562	$ 25,519
Fair value of plan assets	27,252	23,926
Net funded status	$ 4,690	$ (1,593)

The amounts recognized in the consolidated balance sheets consist of:

(in thousands)	December 31, 2021	2020
Other long term assets (liabilities)	$ 4,690	$ (1,593)
Deferred income tax liabilities	(891)	-
Recognized in accumulated other comprehensive loss	$ 3,799	$ (1,593)

The weighted average assumptions used in determining the net pension cost for these plans follows:

	Year Ended December 31,	
	2021	2020
Discount rate	1.8%	1.4%
Expected return on assets	2.8%	3.4%

The discount rate assumptions used for pension accounting reflect the prevailing rates available on high-quality, fixed-income debt instruments with terms that match the average expected duration of the Company's defined benefit pension plan obligations.

The Company's mix of pension plan investments among asset classes also affects the long-term expected rate of return on plan assets. As of December 31, 2021, the Company's actual asset mix approximated its target mix. Differences between actual and expected returns are recognized in the calculation of net periodic pension cost over the average remaining expected future working lifetime, which is approximately 8 years of active plan participants.

The fair value and asset allocations of the Company's pension benefits as of December 31, 2021 and 2020 measurement dates were as follows:

	December 31,			
(in thousands)	2021		2020	
Asset category:				
Equity securities	$ 14,295	52%	$ 12,047	50%
Debt securities	4,720	17%	4,605	19%
Liability driven investment funds	5,722	21%	5,168	22%
Cash and cash equivalents	1,907	7%	1,860	8%
Other	608	2%	246	1%
Total	$ 27,252	100%	$ 23,926	100%

Financial reporting standards define a fair value hierarchy that consists of three levels. The fair values of the plan assets by fair value hierarchy level as of December 31, 2021 and 2020, is as follows:

	December 31,	
(in thousands)	2021	2020
Quoted Prices in Active Markets for Identical Assets (Level 1)	$ 1,907	$ 1,860
Significant Other Observable Inputs (Level 2)	25,345	22,066
Significant Other Unobservable Inputs (Level 3)	-	-
Total	$ 27,252	$ 23,926

Level 1 assets consist of cash and cash equivalents held in the pension plans. The Level 2 assets primarily consist of investments in private investment funds that are valued using the net asset values provided by the trust or fund, including an insurance contract. Although these funds are not traded in an active market with quoted prices, the investments underlying the net asset value are based on quoted prices.

The Company expects to contribute approximately $1.1 million to its pension plans during 2022. The benefits expected to be paid from the pension plans are $0.7 million in 2022, $0.8 million in 2023, $0.7 million in 2024, $0.9 million in 2025 and $1.0 million in 2026. The expected benefits to be paid in the five years from 2027 to 2031 are $4.8 million. The expected benefits are based on the same assumptions used to measure the Company's benefit obligations at December 31, 2021.

9. Leases

The Company has noncancelable operating leases for office space, manufacturing facilities, warehouse space, automobiles and equipment expiring at various dates through 2030.

The components of lease expense for the year ended December 31, 2021 and 2020 are as follows:

	Year Ended December 31,	
(in thousands)	**2021**	**2020**
Operating lease cost	$ 2,041	$ 2,153
Short term lease cost	196	175
Sublease income	(102)	(183)
Total lease cost	$ 2,135	$ 2,145

Supplemental cash flow information related to the Company's operating leases was as follows:

	Year Ended December 31,	
(in thousands)	**2021**	**2020**
Cash paid for amounts included in the measurement of lease liabilities:	$ 2,365	$ 2,717
Right of use assets obtained in exchange for lease obligations:	524	455

Supplemental balance sheet information related to the Company's operating leases was as follows:

	December 31,	
(in thousands)	**2021**	**2020**
Operating lease right-of use assets	$ 6,897	$ 7,761
Operating lease liabilities, current	$ 2,142	$ 2,111
Operating lease liabilities, long term	6,488	7,481
Total operating lease liabilities	$ 8,630	$ 9,592
Weighted average remaining lease term (in years)	6.7	7.4
Weighted average discount rate	9.3%	9.3%

Future minimum lease payments for operating leases, with initial terms in excess of one year at December 31, 2021, are as follows:

(in thousands)	
2022	$ 2,142
2023	2,122
2024	1,768
2025	1,014
2026	980
Thereafter	3,869
Total lease payments	11,895
Less interest	(3,265)
Total operating lease liabilities	$ 8,630

10. Capital Stock and Stock-Based Compensation

Retirement of Treasury Stock

In May 2021, the Company retired the 7,745,507 shares of common stock held by the Company as treasury shares and returned these shares to the status of authorized and unissued shares of common stock.

Preferred Stock

The Company's Board of Directors has the authority to issue up to 5.0 million shares of preferred stock and to determine the price privileges and other terms of the shares. The Board of Directors may exercise this authority without any further approval of stockholders. As of December 31, 2021 and 2020, the Company had no preferred stock issued or outstanding.

Employee Stock Purchase Plan ("ESPP")

Under the ESPP, participating employees can authorize the Company to withhold a portion of their base pay during consecutive six-month payment periods for the purchase of shares of the Company's common stock. At the conclusion of the period, participating employees can purchase shares of the Company's common stock at 85% of the lower of the fair market value of the Company's common stock at the beginning or end of the period. Shares are issued under the ESPP for the six-month periods ending June 30 and December 31. There were 95,507 and 126,255 shares issued under the ESPP during the years ended December 31, 2021 and 2020, respectively. As of December 31, 2021, there were 96,834 shares available for issuance under the ESPP.

Equity Incentive Plans

During 2021, the Company's Board of Directors and stockholders adopted the 2021 Incentive Plan which authorizes approximately 2.2 million additional shares available for grants to officers, employees, non-employee directors and other key persons of the Company and its subsidiaries. Approximately 2.1 million shares available under the prior plan were also made available for issuance under the 2021 Incentive Plan. As of December 31, 2021, there were approximately 4.1 million shares available for issuance under the 2021 Incentive Plan.

Restricted Stock Units with a Market Condition

The Company grants deferred stock awards of Market Condition RSUs (the "Market Condition RSUs") to certain members of the Company's management team. The vesting of the Market Condition RSUs is linked to the achievement of a relative total shareholder return of the Company's common stock measured from the earlier of (i) the measurement period as set out in the award agreement or (ii) upon a change of control (measured relative to the Nasdaq Biotechnology or Russell 2000 index and based on a 20-day trading average price).

For Market Condition RSUs granted during the years ended December 31, 2021 and 2020, the total shareholder return of the Company's common stock relative to the applicable index resulted in a positive performance factor adjustment and the issuance of 163,216 and 233,055 of additional awards during the year ended December 31, 2021 and 2020, respectively. Of the 860,155 Market Condition RSUs granted and subject to vesting as of December 31, 2021, there are 293,509 which remain subject to a relative total shareholder return measurement which can result in vesting rates ranging from -0-% to 150% of the target number.

Stock-Based Payment Awards

The Company accounts for stock-based payment awards in accordance with the provisions of FASB ASC 718, which requires it to recognize compensation expense for all stock-based payment awards made to employees and directors including stock options, restricted stock units, Market Condition RSUs and employee stock purchases related to the ESPP. The Company has elected as an accounting policy to account for forfeitures for service-based awards as they occur, with no adjustment for estimated forfeitures.

Stock option and restricted stock unit activity under the Company's Incentive Plans for the years ended December 31, 2021 and 2020 were as follows:

	Stock Options		Restricted Stock Units		Market Condition RSU's	
	Stock Options Outstanding	Weighted Average Exercise Price	Restricted Stock Units Outstanding	Grant Date Fair Value	Market Condition RSU's Outstanding	Grant Date Fair Value
Balance at December 31, 2019	2,266,122	$ 3.93	1,590,450	$ 2.27	529,491	$ 1.67
Granted	894,154	2.61	1,027,486	2.75	332,622	2.98
Exercised	(253,853)	3.94	-	-	-	-
Vested (RSUs)	-	-	(930,985)	2.41	(240,205)	1.53
Cancelled/Forfeited	(269,084)	3.68	(126,490)	3.13	(41,932)	3.04
Performance Factor Adjustment	-	-	-	-	233,055	1.47
Balance at December 31, 2020	2,637,339	3.51	1,560,461	$ 2.44	813,031	2.12
Granted	-	-	820,831	4.74	293,509	4.61
Exercised	(579,968)	3.77	-	-	-	-
Vested (RSUs)	-	-	(1,167,473)	2.88	(403,422)	2.11
Cancelled/Forfeited	(652,555)	4.24	(72,655)	3.67	(6,179)	2.98
Performance Factor Adjustment	-	-	-	-	163,216	2.98
Balance at December 31, 2021	1,404,816	$ 3.10	1,141,164	$ 3.57	860,155	$ 3.13

Earnings per share

Basic earnings per share is based upon net income divided by the number of weighted average common shares outstanding during the period. The calculation of diluted earnings per share assumes conversion of stock options, restricted stock units and Market Condition RSUs into common stock using the treasury method. The weighted average number of shares used to compute basic and diluted earnings per share consists of the following:

	Year Ended December 31,	
(in thousands)	2021	2020
Basic	40,343	38,640
Dilutive effect of equity awards	-	-
Diluted	40,343	38,640

For the years ended December 30, 2021 and 2020, the Company excluded from the calculations of diluted earnings per share approximately 4.3 million shares and 5.0 million shares, respectively, of weighted average shares of underlying stock-based awards as the impact of including these potential shares would be anti-dilutive.

The following table summarizes outstanding and exercisable options as of December 31, 2021 (Aggregate Intrinsic Value, in thousands):

	Options Outstanding				Options Exercisable			
Range of Exercise Price	Number Outstanding	Weighted Average Remaining Contractual Life in Years	Weighted Average Exercise Price	Aggregate Intrinsic Value	Shares Exercisable	Weighted Average Remaining Contractual Life in Years	Weighted Average Exercise Price	Aggregate Intrinsic Value
$ 1.78 - 2.62	188,253	6.4	$ 2.08	$ 935	90,551	6.1	$ 2.09	$ 449
2.63 - 2.78	586,160	5.4	2.63	2,591	234,299	5.4	2.63	1,036
2.79 - 3.24	160,071	7.6	2.95	656	99,751	7.5	2.95	409
3.25 - 3.72	206,808	5.2	3.38	760	206,808	5.2	3.38	760
3.73 - 5.51	263,524	4.3	4.73	611	219,931	3.7	4.91	471
$ 1.78 - 5.51	1,404,816	5.6	$ 3.10	$ 5,553	851,340	5.2	$ 3.38	$ 3,125

The aggregate intrinsic value in the preceding table represents the total pre-tax intrinsic value, based on the Company's closing stock price of $7.05 as of December 31, 2021, which would have been received by the option holders had all option holders exercised their options as of that date. The aggregate intrinsic value of options exercised was $1,310,765 and $92,162 for the years ended December 31, 2021 and 2020, respectively.

As of December 31, 2021, the total compensation costs related to unvested awards not yet recognized is $5.2 million and the weighted average period over which it is expected to be recognized is approximately 1.9 years.

Valuation and Expense Information under Stock-Based-Payment Accounting

Stock-based compensation expenses related to stock options, restricted stock units, Market Condition RSU's and the ESPP for the years ended December 31, 2021 and 2020 was allocated as follows:

	Year Ended December 31,	
(in thousands)	2021	2020
Cost of revenues	$ 118	$ 65
Sales and marketing expenses	507	263
General and administrative expenses	3,416	3,122
Research and development expenses	128	197
Total stock-based compensation expenses	$ 4,169	$ 3,647

The Company did not capitalize any stock-based compensation.

The weighted-average estimated fair value per share of stock options granted during the year ended December 31, 2020 was $1.21, using the Black-Scholes option-pricing model with the following weighted-average assumptions:

	2020
Volatility	58.3%
Risk-free interest rate	0.3%
Expected holding period (in years)	4.4
Dividend Yield	-%

The weighted average estimated fair value per share of the Market Condition RSUs granted during the year ended December 31, 2021 and 2020 was $4.61 and $2.98, respectively, using a Monte-Carlo valuation simulation, with the following weighted-average assumptions:

	2021	2020
Volatility	65.1%	80.6%
Risk-free interest rate	0.3%	0.2%
Correlation coefficient	35.7%	31.5%
Dividend yield	-%	-%

The Company used historical volatility to calculate the expected volatility. Historical volatility was determined by calculating the mean reversion of the daily adjusted closing stock price. The risk-free interest rate assumption is based upon observed U.S. Treasury bill interest rates (risk-free) appropriate for the term of the Company's stock options. The expected holding period of stock options represents the period of time options are expected to be outstanding and were based on historical experience. The vesting period ranges from one to four years and the contractual life is ten years.

11. Long Term Debt

As of December 31, 2021 and December 31, 2020, the Company's borrowings were comprised of the following:

	December 31,	
(in thousands)	2021	2020
Long-term debt:		
Term loan	$ 38,000	$ 40,000
Revolving line	11,450	9,400
Less unamortized deferred financing costs	(1,120)	(1,393)
Total debt	48,330	48,007
Current portion of long-term debt	(3,515)	(2,000)
Current unamortized deferred financing costs	280	279
Long-term debt	$ 45,095	$ 46,286

The aggregate amounts of debt maturing during the next five years are as follows:

(in thousands)	
2022	$ 3,515
2023	3,000
2024	4,000
2025	38,935
	$ 49,450

On December 22, 2020, the Company entered into a Credit Agreement (the "Credit Agreement") with Citizens Bank, N.A., Wells Fargo Bank, National Association, and Silicon Valley Bank, (together, the "Lenders"). The Credit Agreement provides for a term loan of $40.0 million and a $25.0 million senior revolving credit facility (including a $10.0 million sub-facility for the issuance of letters of credit and a $10.0 million swingline loan sub-facility) (collectively, the "Credit Facility"). The Company's obligations under the Credit Agreement are guaranteed by certain of the Company's direct, domestic wholly-owned subsidiaries; none of the Company's direct or indirect foreign subsidiaries has guaranteed the Credit Facility. The Company's obligations under the Credit Agreement are secured by substantially all of the assets of Harvard Bioscience, Inc. and each guarantor (including all or a portion of the equity interests in certain of the Company's domestic and foreign subsidiaries). The Credit Facility matures on December 22, 2025. Issuance costs of $1.3 million are amortized over the contractual term to maturity date on a straight-line basis, which approximates the effective interest method. As of December 31, 2021, available borrowing capacity under the revolving line of credit was $13.6 million.

The Credit Facility replaced the Company's prior credit agreement which consisted of a revolving credit facility and a term loan that was scheduled to expire on January 31, 2023. On December 22, 2020, the Company paid the prior credit facility outstanding borrowing balance of $46.7 million, paid $0.6 million in debt extinguishment costs, and wrote off the remaining balance of its unamortized debt issuance cost which amounted to $0.8 million. The write-off of the unamortized debt issuance costs is included in the Other expense – debt extinguishment and related costs in the Consolidated Statements of Operations. The Company financed the payoff of the outstanding borrowings under the prior credit facility with borrowings under the Credit Agreement.

Borrowings under the Credit Facility will, at the option of the Company, bear interest at either (i) a rate per annum based on LIBOR for an interest period of one, two, three or six months, plus an applicable interest rate margin determined as provided in the Credit Agreement (a "LIBOR Loan"), or (ii) an alternative base rate plus an applicable interest rate margin, each as determined as provided in the Credit Agreement (an "ABR Loan"). LIBOR interest under the Credit Agreement is subject to applicable market rates and a floor of 0.50 %. The alternative base rate is based on the bank prime rate or the federal funds effective rate of the Federal Reserve Bank of New York and is subject to a floor of 1.0%. The applicable interest rate margin varies from 2.0% per annum to 3.25% per annum for LIBOR Loans, and from 1.5% per annum to 3.0% per annum for ABR Loans, in each case depending on the Company's consolidated leverage ratio and is determined in accordance with a pricing grid set forth in the Credit Agreement (the "Pricing Grid"). Interest on LIBOR Loans is payable in arrears on the last day of each applicable interest period, and interest on ABR Loans is payable in arrears at the end of each calendar quarter. There are no prepayment penalties in the event the Company elects to prepay and terminate the Credit Facility prior to its scheduled maturity date, subject to LIBOR breakage and redeployment costs in certain circumstances.

Commencing on March 31, 2021, the outstanding term loans amortizes in equal quarterly installments equal to $0.5 million per quarter on such date and during each of the next three quarters thereafter, $0.75 million per quarter during the next eight quarters thereafter and $1.0 million per quarter thereafter, with a balloon payment at maturity. Furthermore, within ninety days after the end of the Company's fiscal year ended December 31, 2021 and for each fiscal year thereafter, the term loans may be permanently reduced pursuant to certain mandatory prepayment events including an annual "excess cash flow sweep" of 50% of the consolidated excess cash flow, as defined in the agreement; provided that, in any fiscal year, any voluntary prepayments of the term loans shall be credited against the Company's "excess cash flow" prepayment obligations on a dollar-for-dollar basis for such fiscal year. Amounts outstanding under the revolving credit facility can be repaid at any time but are due in full at maturity. As of December 31, 2021, the current portion of long-term debt includes an excess cash flow sweep of $0.5 million to be paid by March 31, 2022.

The Credit Agreement includes customary affirmative, negative, and financial covenants binding on the Company. The negative covenants limit the ability of the Company, among other things, to incur debt, incur liens, make investments, sell assets and pay dividends on its capital stock. The financial covenants include a maximum consolidated net leverage ratio and a minimum consolidated fixed charge coverage ratio. The Credit Agreement also includes customary events of default.

As of December 31, 2021 and 2020, the weighted effective interest rate on the Credit Agreement borrowings was 3.0% and 3.25%, respectively. The carrying value of the debt approximates fair value because the interest rate under the obligation approximates market rates of interest available to the Company for similar instruments.

On April 18, 2020, the Company entered into a promissory note with PNC Bank, National Association, which provided for a loan in the amount of $6.1 million (the "PPP Loan") pursuant to the Paycheck Protection Program (the "PPP") of the Coronavirus Aid, Relief, and Economic Security Act (the "CARES Act") administered by the U.S. Small Business Administration (the "SBA"). On April 23, 2020, the SBA, in consultation with the U.S. Department of the Treasury issued guidance regarding consideration of alternate available sources of liquidity and its impact on qualification for PPP loans. The Company reassessed its business plans and liquidity available under its existing credit facility and elected to repay all PPP funds. The PPP Loan was repaid in full on May 4, 2020.

Derivatives

The Company monitors interest rate risk attributable to both its outstanding and forecasted debt obligations by the use of cash flow sensitivity analysis which estimates the expected impact of changes in interest rates on the Company's future cash flows.

On January 31, 2018, the Company entered into an interest rate swap contract with a notional amount of $36.0 million and a termination date of January 1, 2023. This swap contract, which converted specific variable-rate debt into fixed-rate debt and fixed the LIBOR rate associated with a portion of the term loan under the Company's prior credit facility at 2.72% was cancelled on December 22, 2020, in connection with the new Credit Agreement as described above. The Company paid $0.5 million to cancel its outstanding interest rate swap agreement with PNC Bank (notional value of $23.0 million). The cancellation amount represented the fair value of the contracts at the time and was recorded as debt extinguishment and related costs in the Consolidated Statements of Operations.

The Company structured this interest rate swap to be fully effective in accordance with ASC 815 "Derivatives and Hedging", and therefore changes in the fair value of the swap offset the variability of cash flows associated with the variable-rate, long-term debt obligations and were reported in accumulated other comprehensive income (AOCI). These amounts subsequently were reclassified into interest expense as a yield adjustment of the hedged interest payments in the same period in which the related interest affects earnings.

The following table summarizes the effect of interest rate swap derivatives designated as cash flow hedging instruments and their classification within the consolidated financial statements for the year ended December 31, 2020:

(in thousands)	Location	Year Ended December 31, 2020
Amount of loss recognized in OCI	Other comprehensive loss	$ (206)
Amount reclassified from AOCI into income	Interest expense	319
	Debt extinguishment and related costs	490
		809
Total		$ 603

12. Revenues

The following table represents a disaggregation of revenue from contracts with customers for the years ended December 31, 2021 and 2020:

	Year Ended December 31,	
(in thousands)	2021	2020
Instruments, equipment, software and accessories	$ 114,115	$ 97,473
Service, maintenance and warranty contracts	4,789	4,627
Total revenues	$ 118,904	$ 102,100

Deferred revenue

The following tables provide details of deferred revenue as of the periods indicated:

	December 31,	
(in thousands)	2021	2020
Service contracts	$ 1,976	$ 1,629
Customer advances	2,290	2,142
Total deferred revenue	$ 4,266	$ 3,771

During each of the years ended December 31, 2021 and 2020, the Company recognized revenue of $2.0 million from contract liabilities existing at December 31, 2020 and 2019.

Allowance for Doubtful Accounts

Allowance for doubtful accounts is based on the Company's assessment of the collectability of customer accounts. A rollforward of allowance for doubtful accounts is as follows:

	December 31,	
(in thousands)	2021	2020
Balance, beginning of period	$ 227	$ 325
Bad debt (credit) expense	(4)	17
Charge-offs and other	(87)	(115)
Balance, end of period	$ 136	$ 227

Concentrations

No customer accounted for more than 10% of the revenues for the years ended December 31, 2021, and 2020. At December 31, 2021 and 2020, no customer accounted for more than 10% of net accounts receivable.

Warranties

Warranties are estimated and accrued at the time revenues are recorded. A rollforward of the Company's product warranty accrual is as follows:

	December 31,	
(in thousands)	**2021**	**2020**
Balance, beginning of period	$ 186	$ 252
Expense	319	77
(Charges)/Credits	(265)	(143)
Balance, end of period	$ 240	$ 186

13. Income Tax

Income tax expense for years ended December 31, 2021 and 2020 consisted of:

	Year Ended December 31,	
(in thousands)	**2021**	**2020**
Current income tax expense:		
Federal and state	$ 363	$ 169
Foreign	156	492
	519	661
Deferred income tax (benefit) expense:		
Federal and state	22	245
Foreign	(393)	(388)
	(371)	(143)
Total income tax expense	$ 148	$ 518

The effective tax rate for the year ended December 31, 2021 was (105.7)% as compared with (7.1)% for the same period in 2020. The difference between the Company's effective tax rate year over year was primarily attributable to changes in the mix of pre-tax income and losses at individual subsidiaries as well as the impact of different tax rates in certain foreign jurisdictions, and the impact of the change in valuation allowance.

Income tax expense for the years ended December 31, 2021 and 2020 differed from the amount computed by applying the U.S. federal income tax rate of 21% to pre-tax operations income as a result of the following:

	Year Ended December 31,	
(in thousands)	**2021**	**2020**
Provision for income taxes at federal statutory rates	$ (29)	$ (1,531)
Increase (decrease) in income taxes resulting from:		
Permanent differences, net	(78)	141
Foreign tax rate differential	(217)	(14)
State income taxes, net of federal income tax benefit	(16)	(77)
Non-deductible stock compensation expense	408	94
Tax credits	455	(192)
Change in reserve for uncertain tax position	(118)	259
Impact of change to prior year tax accruals	464	168
Change in valuation allowance allocated to income tax	(961)	2,130
Other	240	(460)
Total income tax expense	$ 148	$ 518

Income tax expense is based on the following pre-tax income (loss) from operations:

(in thousands)	Year Ended December 31, 2021	2020
Domestic	$ 2,364	$ (7,954)
Foreign	(2,504)	662
Total	$ (140)	$ (7,292)

The tax effects of temporary differences that give rise to significant components of the deferred tax assets and deferred tax liabilities at December 31, 2021 and 2020 are as follows:

(in thousands)	Year Ended December 31, 2021	2020
Deferred income tax assets:		
Inventory	$ 1,280	$ 1,144
Operating loss and credit carryforwards	18,046	19,220
Accrued expenses	835	555
Deferred interest expense	1,191	1,476
Stock compensation	580	1,079
Lease liability	1,693	1,823
Other assets	386	458
Total gross deferred assets	24,011	25,755
Less: valuation allowance	(14,700)	(16,682)
Deferred tax assets	$ 9,311	$ 9,073
Deferred income tax liabilities:		
Indefinite-lived intangible assets	$ 1,882	$ 1,822
Definite-lived intangible assets	6,277	7,493
Right-of-use asset	1,277	1,388
Other liabilities	1,228	14
Total deferred tax liabilities	10,664	10,717
Deferred income tax liability, net	$ (1,353)	$ (1,644)

Deferred income tax assets and liabilities by classification on the consolidated balance sheets were as follows:

(in thousands)	Year Ended December 31, 2021	2020
Deferred income tax assets (included in other long-term assets)	$ 205	$ 255
Deferred income tax liabilities	(1,558)	(1,899)
Deferred income tax liability, net	$ (1,353)	$ (1,644)

As of December 31, 2021 and 2020, the Company maintained a total valuation allowance of $14.7 million and $16.7 million, respectively, which relates to foreign, federal, and state deferred tax assets in both years. The valuation allowance is based on estimates of taxable income in each of the jurisdictions in which the Company operates and the period over which deferred tax assets will be recoverable. The net change in total valuation allowance for each of the years ended December 31, 2021 and December 31, 2020 was a decrease of $2.0 million and an increase of $2.9 million, respectively. The decrease in the valuation allowance in 2021 is primarily due to a change in estimate of the realizability of UK deferred tax assets and the utilization and expiration of certain U.S. net operating losses and the expiration of certain U.S. credits. A valuation allowance decrease of $0.9 million was recorded to equity during the year ended December 31, 2021 related to the UK pension liability. The movement in the valuation allowance in 2020 is primarily due to increases in the valuation allowance against net operating losses (NOLs) as a result of changes made by the Coronavirus Aid, Relief, and Economic Security Act (“CARES Act”) and movement of $0.7 million was recorded to equity during the year ended December 31, 2020 related to the UK pension asset.

At December 31, 2021, the Company had U.S. federal net operating loss carryforwards of $22.7 million, of which $22.6 expires between 2029 and 2037. The Company's state net operating loss carryforwards of $16.4 million expire between 2022 and 2041. The Company has net operating loss carryforwards of $9.9 million in certain foreign jurisdictions which may be carried forward indefinitely, partially offset by valuation allowances. The Company has $8.4 million of research and development tax credit carryforwards and foreign tax credits of $0.2 million which begin to expire in 2022. Approximately $1.0 million of the research and development tax credit carryforwards are offset by a reserve for uncertain tax positions. In addition, the Company had a total of $2.9 million of state investment tax credit carryforwards, research and development tax credit carryforwards, and enterprise zone credit carryforwards, which begin to expire in 2023. The Internal Revenue Code (IRC) limits the amounts of net operating loss carryforwards or credits that a company may use in any one year in the event of a change in ownership under IRC Sections 382 or 383. As a result of the DSI acquisition as well as other acquisitions in prior years, certain losses and credit carryforwards are subject to these limitations. The Company has provided a full or partial valuation allowance for the portion of state NOLs and federal and state credit carryforwards the Company expects will expire before use.

As of December 31, 2021 and December 31, 2020, cash and cash equivalents held by the Company's foreign subsidiaries was $2.8 million and $2.5 million, respectively. As of December 31, 2021, the Company has determined the potential income tax and withholding liability related to available cash balances at foreign subsidiaries to be immaterial.

At December 31, 2021 and 2020 the amount of unrecognized tax benefits that would affect the Company's effective tax rate are shown in the table below:

(in thousands)		
Balance at December 31, 2019	$	1,353
Additions based on tax positions of prior years		157
Decreases based on tax positions of prior years		(11)
Additions based on tax positions of current years		213
Settlements and other		(39)
Balance at December 31, 2020		1,673
Additions based on tax positions of prior years		-
Decreases based on tax positions of prior years		(208)
Additions based on tax positions of current years		176
Decreases based on expiration of statutes of limitation		(42)
Settlements and other		(267)
Balance at December 31, 2021	$	1,332

The Company does not anticipate that any portion of the total unrecognized tax benefits will be reduced within the next 12 months. The total amount of unrecognized tax benefits that, if recognized, would impact the effective tax rate is $1.3 million. The Company classifies interest and penalties related to unrecognized tax benefits as a component of income tax expense, which has not been significant during the years ended December 31, 2021 and 2020, respectively.

The Company or one of its subsidiaries files income tax returns in the U.S. federal jurisdiction, and various states and foreign jurisdictions. With few exceptions, the Company is no longer subject to income tax examinations by tax authorities in foreign jurisdictions for years before 2017. In the U.S., the Company's net operating loss and tax credit carryforward amounts remain subject to federal and state examination for tax years starting in 2002 as a result of tax losses incurred in prior years. There are currently no pending federal or state tax examinations.

On March 27, 2020, the CARES Act was signed into law. Under the CARES Act, the limitation on the deduction of business interest under Section 163j of the Internal Revenue Code was increased to 50% of adjusted taxable income (from 30%) for taxable years beginning in 2019 or 2020. In addition, the CARES Act corrected the Tax Cuts and Jobs Act to provide that net operating losses with unlimited carryover period are those arising in tax years beginning after December 31, 2017, rather than in tax years ending after that date. This change impacted $5.3 million of NOLs from the DSI acquisition in 2018, which no longer have an unlimited carryforward period. As a result, the Company increased the valuation allowance against these NOLs by $1.1 million.

14. Commitments and Contingent Liabilities

On April 14, 2017, representatives for the estate of an individual plaintiff filed a wrongful death complaint with the Suffolk Superior Court, in the County of Suffolk, Massachusetts (the "Court"), against the Company and other defendants, including Biostage, Inc. (f/k/a Harvard Apparatus Regenerative Technology, Inc.) ("Biostage"), a former subsidiary of the Company that was spun off in 2013, as well as another third party. The complaint seeks payment for an unspecified amount of damages and alleges that the plaintiff sustained terminal injuries allegedly caused by products, including one synthetic trachea scaffold and two bioreactors, provided by certain of the named defendants and utilized in connection with surgeries performed by third parties in Europe in 2012 and 2013.

On September 15, 2021, Biostage's products liability insurance carrier, which insures the Company as an additional insured and which had appointed defense counsel and had been defending both Biostage and the Company on this case, notified the Company and Biostage that it was denying coverage under the applicable policy for the lawsuit and would no longer be providing a defense to the Company or Biostage with respect thereto, or covering related legal expenses incurred after September 30, 2021. The insurance carrier also filed a corresponding complaint for declaratory judgment with the Court asking the Court to declare that said insurance provider is not required to defend, indemnify or provide coverage to the Company or Biostage with respect to the lawsuit.

On January 24, 2022, the Superior Court, Suffolk County, granted the Company's and Biostage's jointly filed motion for a preliminary injunction against the insurance carrier requiring that it continue to pay legal expenses incurred by Biostage and the Company in connection with the underlying lawsuit during the pendency of the insurance coverage lawsuit, as well as awarding reasonable attorneys' fees and costs incurred by the parties in connection with seeking the preliminary injunction. The insurance carrier has filed a notice of appeal of the preliminary injunction.

The Company continues to believe that the insurance carrier's grounds for denying coverage are without merit, and intends to vigorously defend against this complaint for declaratory judgment and the insurance carrier's denial of the claim and related matters in order to, among other things, restore the Company's rights to seek insurance coverage for any damages awarded in the lawsuit. However, notwithstanding the preliminary injunction, there can be no assurance that the Company and Biostage will prevail in the insurance coverage litigation. As such, other than what has been ordered in the preliminary injunction, it is unclear at this point the full extent to which the Company's liability insurance coverage will reimburse the Company for all or any portion of any defense costs or damages incurred in connection with the underlying case.

Additionally, while there can be no assurance of prevailing, the Company intends to defend the plaintiff's claims against the Company in the underlying case vigorously. A trial date has been set for October 2022 and the parties are currently preparing for trial. If the Company loses on the merits and a jury awards damages, the Company does not know the exact amount of compensatory and, potentially, punitive damages that could be awarded, but the amounts could be substantial. Further, while Biostage has agreed to indemnify the Company for claims and losses relating to certain liabilities that it has assumed from the Company, including liabilities in connection with the sale of Biostage's products and other liabilities related to the operation of Biostage's business, the Company cannot be assured that Biostage will have the ability to indemnify the Company against the liabilities the Company may incur in this lawsuit, in particular due to Biostage's overall financial condition. If Biostage is unable to satisfy its obligations under its indemnity to the Company and if the insurance carrier does not fund the defense of the case, the Company may have to fund the entire defense of the case and satisfy the liabilities in this lawsuit, which could have an adverse impact on the Company's financial condition or cash flows.

The Company is involved in various other claims and legal proceedings arising in the ordinary course of business. After consultation with legal counsel, the Company has determined that the ultimate disposition of such proceedings is not likely to have a material adverse effect on its business, financial condition, results of operations or cash flows. Although unfavorable outcomes in the proceedings are possible, the Company has not accrued for loss contingencies relating to any such matters as they are not considered to be probable and reasonably estimable. If one or more of these matters are resolved in a manner adverse to the Company, the impact on the Company's business, financial condition, results of operations and cash flows could be material.

15. Segment and Related Information

Operating segments are determined by products and services provided by each segment, internal organization structure, the manner in which operations are managed, criteria used by the Chief Operating Decision Maker, or CODM, to assess the segment performance, as well as resource allocation and the availability of discrete financial information. The Company has one operating segment and therefore segment results and consolidated results are the same.

The following tables summarize additional selected financial information of the Company's operations by geographic location.

Revenues by geographic destination are as follows:

	Year Ended December 31,	
(in thousands)	2021	2020
United States	$ 49,831	$ 42,054
Europe	35,767	29,938
Asia	24,816	23,884
Rest of World	8,490	6,224
Total revenues	$ 118,904	$ 102,100

Long-lived assets by geographic area include operating lease right-of-use assets, property, plant and equipment, and amortizable intangible assets, are as follows:

	December 31,	
(in thousands)	2021	2020
United States	$ 31,512	$ 36,568
Germany	3,501	4,958
Rest of World	2,446	3,092
Total long-lived assets	$ 37,459	$ 44,618

Net assets by geographic area are as follows:

	December 31,	
(in thousands)	2021	2020
United States	$ 38,641	$ 32,457
Germany	15,501	18,697
United Kingdom	13,999	8,867
Rest of World	15,260	16,660
Total net assets	$ 83,401	$ 76,681

SIGNATURES

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

HARVARD BIOSCIENCE, INC.

Date: March 11, 2022

By: /s/ JAMES GREEN
James Green
Chief Executive Officer

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the dates indicated

Signature	Title	Date
/s/ JAMES GREEN **James Green**	Chief Executive Officer and Director (Principal Executive Officer)	March 11, 2022
/s/ MICHAEL A. ROSSI **Michael A. Rossi**	Chief Financial Officer (Principal Financial Officer and Principal Accounting Officer)	March 11, 2022
/s/ KATHERINE A. EADE **Katherine A. Eade**	Director	March 11, 2022
/s/ ALAN EDRICK **Alan Edrick**	Director	March 11, 2022
/s/ THOMAS W. LOEWALD **Thomas W. Loewald**	Director	March 11, 2022
/s/ BERTRAND LOY **Bertrand Loy**	Director	March 11, 2022

EXHIBIT INDEX

The following exhibits are filed as part of this Annual Report on Form 10-K. Where such filing is made by incorporation by reference to a previously filed document, such document is identified.

Exhibit	Description	Method of Filing
2.1§	Separation and Distribution Agreement between Harvard Bioscience, Inc. and Biostage, Inc. (f/k/a Harvard Apparatus Regenerative Technology, Inc.) dated as of October 31, 2013.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed November 6, 2013) and incorporated by reference thereto.
3.1	Second Amended and Restated Certificate of Incorporation of Harvard Bioscience, Inc.	Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on November 9, 2000) and incorporated by reference thereto.
3.2	Amended and Restated By-laws of Harvard Bioscience, Inc.	Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on November 9, 2000) and incorporated by reference thereto.
3.3	Amendment No. 1 to Amended and Restated Bylaws of Harvard Bioscience, Inc. (as adopted October 30, 2007).	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed on November 1, 2007) and incorporated by reference thereto.
4.1	Specimen certificate for shares of Common Stock, $0.01 par value, of Harvard Bioscience, Inc.	Previously filed as an exhibit to the Company's Registration Statement on Form S-1/A (File No. 333-45996) (filed on November 9, 2000) and incorporated by reference thereto.
4.2	Description of Securities.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2020) and incorporated by reference thereto
10.1 #	Harvard Bioscience, Inc. Fourth Amended and Restated 2000 Stock Option and Incentive Plan.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed August 10, 2020) and incorporated by reference thereto.
10.2	Harvard Bioscience, Inc. Employee Stock Purchase Plan, as amended.	Previously disclosed as Appendix A to the Company's Proxy Statement on Schedule 14A (filed April 5, 2019) and incorporated by reference thereto
10.3	Form of Director Indemnification Agreement.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed May 8, 2020) and incorporated by reference thereto.
10.4 +	Trademark License Agreement, dated December 19, 2002, by and between Harvard Bioscience, Inc. and President and Fellows of Harvard College.	Previously filed as an exhibit to the Company's Quarterly Report on Form 10-Q (filed May 15, 2003) and incorporated by reference thereto
10.5 #	Form of Incentive Stock Option Agreement (Executive Officers).	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2006) and incorporated by reference thereto
10.6 #	Form of Non-Qualified Stock Option Agreement (Executive Officers).	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2006) and incorporated by reference thereto
10.7 #	Form of Non-Qualified Stock Option Agreement (Non-Employee Directors).	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2006) and incorporated by reference thereto
10.8 #	Form of Deferred Stock Award Agreement.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2011) and incorporated by reference thereto
10.9 #	Form of Market Condition Deferred Stock Award Agreement.	Previously filed as an exhibit to the Company's Annual Report on Form 10-K (filed March 16, 2020) and incorporated by reference thereto
10.10 #	Employment Agreement between Harvard Bioscience, Inc. and James Green.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed July 8, 2019) and incorporated by reference thereto.
10.11 #	Employment Agreement between Harvard Bioscience, Inc. and Michael Rossi.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed July 19, 2019) and incorporated by reference thereto.
10.12	Consulting Agreement, dated as of March 2, 2020, by and between Harvard Bioscience, Inc. and Chane Graziano.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed March 6, 2020) and incorporated by reference thereto.
10.13	Credit Agreement dated as of December 22, 2020 among Harvard Bioscience, Inc., as borrower, the lenders party thereto, and Citizens Bank, N.A., as administrative agent.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed December 23, 2020) and incorporated by reference thereto.
10.14	Pledge and Security Agreement dated as of December 22, 2020 among Harvard Bioscience, Inc., certain of Harvard Bioscience's direct and indirect subsidiaries and Citizens Bank, N.A., as administrative agent.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed December 23, 2020) and incorporated by reference thereto.
10.15	Guarantee Agreement dated as of December 22, 2020 among Harvard Bioscience, Inc., certain of Harvard Bioscience's direct and indirect subsidiaries and Citizens Bank, N.A., as administrative agent.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed December 23, 2020) and incorporated by reference thereto.

10.16#	Harvard Bioscience, Inc. 2021 Incentive Plan.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed May 19, 2021) and incorporated by reference thereto.
10.17#	Form of Performance RSU Award Agreement - 2021 Incentive Plan.	Filed with this report
10.18#	Form of Time-Based RSU Awards Agreement – 2021 Incentive Plan.	Filed with this report
10.19#	Form of RSU Award for Directors – 2021 Incentive Plan.	Filed with this report
10.20#	Separation Agreement and Release between Harvard Bioscience, Inc. and Ken Olson, dated as of January 26, 2022.	Previously filed as an exhibit to the Company's Current Report on Form 8-K (filed January 28, 2022) and incorporated by reference thereto.
21.1	Subsidiaries of the Registrant	Filed with this report
23.1	Consent of Grant Thornton LLP	Filed with this report
31.1	Certification of Chief Financial Officer of Harvard Bioscience, Inc., pursuant to Rules 13a-15(e) and 15d-15(e), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002	Filed with this report
31.2	Certification of Chief Executive Officer of Harvard Bioscience, Inc., pursuant to Rules 13a-15(e) and 15d-15(e), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002	Filed with this report
32.1	Certification of Chief Financial Officer of Harvard Bioscience, Inc., pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002	*
32.2	Certification of Chief Executive Officer of Harvard Bioscience, Inc., pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002	*
101.INS	Inline XBRL Instance Document	Filed with this report
101.SCH	Inline XBRL Taxonomy Extension Schema Document	Filed with this report
101.CAL	Inline XBRL Taxonomy Extension Calculation Linkbase Document	Filed with this report
101.DEF	Inline XBRL Taxonomy Extension Definition Linkbase Document	Filed with this report
101.LAB	Inline XBRL Taxonomy Extension Label Linkbase Document	Filed with this report
101.PRE	Inline XBRL Taxonomy Extension Presentation Linkbase Document	Filed with this report
104	Cover Page Interactive Data File (formatted as Inline XBRL with applicable taxonomy extension information contained in Exhibits 101)	

\+ Certain portions of this document have been granted confidential treatment by the Securities and Exchange Commission (the Commission).

* This certification shall not be deemed "filed" for purposes of Section 18 of the Securities Exchange Act of 1934, or otherwise subject to the liability of that section, nor shall it be deemed to be incorporated by reference into any filing under the Securities Act of 1933 or the Securities Exchange Act of 1934

\# Management contract or compensatory plan or arrangement.

§ The schedules and exhibits have been omitted. A copy of any omitted schedule or exhibit will be furnished to the SEC supplementally upon request.

The Company will furnish to stockholders a copy of any exhibit without charge upon written request.

HARVARD BIOSCIENCE, INC.
2021 INCENTIVE PLAN

NOTICE OF RESTRICTED STOCK UNIT AWARD

Participant Name and Address:

You (the "Participant") have been granted restricted stock units ("Restricted Stock Units" or "RSUs"), subject to the terms and conditions of this Notice of Restricted Stock Unit Award (the "Notice"), the Harvard Bioscience, Inc. 2021 Incentive Plan (as amended from time to time, the "Plan") and the Restricted Stock Unit Award Agreement (the "RSU Agreement") attached hereto, as follows. Unless otherwise defined herein, the terms defined in the Plan shall have the same defined meanings in this Notice.

Date of Grant:
Target Number of RSUs (the "Target Award"):
Vesting Schedule: Participant will receive a benefit with respect to an RSU only if it vests. Subject to the terms set forth in the RSU Agreement attached hereto, to the extent the achieved Performance Factor is greater than 0% as of the end of the Performance Period (as defined below), the Participant shall vest in a number of RSUs (the "Final RSUs") based on the attainment of the total shareholder return ("TSR") performance goals described on Schedule A as of the end of the Performance Period (as defined below) on the last day of the Performance Period. The Performance Period is the period beginning on the Grant Date and ending on December 31, 20[__] (the "Performance Period"). The Participant's Final RSUs will be determined by multiplying the Target Award by the percentage (from zero to 150%) (the "Performance Factor") which is based on the Company's Total Shareholder Return (as defined on Schedule A) during the Performance Period compared to the Index Constituent Companies (as defined on Schedule A), determined according to Schedule A. Except as specifically provided in the RSU Agreement attached hereto, no RSUs will vest for any reason prior to the last day of the Performance Period. Except as provided in the RSU Agreement attached hereto, if the TSR performance goals are not attained at the end of the Performance Period, the RSUs will be immediately forfeited. Upon vesting in accordance herewith or in Sections 4 or 5 of the RSU Agreement attached hereto, such RSU shall become payable to the Participant in shares of Stock on the relevant vesting date in the amount of the vested RSUs in accordance with this paragraph and Schedule A.

HARVARD BIOSCIENCE, INC.
By: _____
Name: _____
Title: _____

Schedule A

Determination of Performance Factor

The Performance Factor shall be determined according to the following table:

Relative TSR Percentile Rank*	**Performance Factor****
Below 25th percentile	0%
25th to 50th percentile	50%, plus an additional 1.923% for each whole percentile above 25th percentile
51st to 74th percentile	100%, plus an additional 2.083% for each whole percentile above 51st percentile
75th percentile or higher	150%
Examples: If the Company's Relative TSR Percentile Rank falls into the 37th percentile (i.e., thirteen percentiles above the 25th percentile), the Performance Factor will be 75% (calculated by multiplying thirteen by 1.923% and adding it to 50%). If the Company's Relative TSR Percentile Rank falls into the 63rd percentile (i.e., twelve percentiles above the 51st percentile), the Performance Factor will be 125% (calculated by multiplying twelve by 2.083% and adding it to 100%).	

* Total Shareholder Return for the Company shall be based on the percentage increase/decrease from the Initial Price to the Final Price, and shall reflect the reinvestment of dividends paid (if any) to shareholders of Stock during the Measurement Period.
** In all cases, if the Total Shareholder Return is negative at the end of the Measurement Period, the Performance Factor is subject to a cap of 100%.

For purposes of the foregoing calculation:

1. "**Total Shareholder Return**" mean the quotient (expressed as a percentage) obtained by dividing (i)(A) the Final Price, plus (B) the aggregate amount of dividends paid in respect of a share of Stock during the Measurement Period (assuming reinvestment of the dividends), minus (C) the Initial Price, by (ii) the Initial Price.

2. "**Initial Price**" means the average closing price of Stock over the twenty trading day period beginning on the first day of the Performance Period.

3. "**Final Price**" means the average closing price of Stock over the twenty trading day period ending on the last day of the Measurement Period, provided that in connection with a Change in Control, the Final Price shall be the per share purchase price in the Change in Control, except in the case of a Change in Control as described in clause (b) of the definition of Change in Control in the Plan, the Final Price shall be the average closing price of Common Stock over the twenty trading day period ending on the date of such Change in Control.

4. "**Measurement Period**" means the Performance Period; provided that in the event of a Change in Control, Total Shareholder Return shall be calculated through the date of the Change in Control as provided in the Agreement.

5. "**Relative TSR Percentile Rank**" means the percentile within the Index Constituent Companies (as defined below) that the Company's Total Shareholder Return would have for the Measurement Period.

6. If the Company's Relative TSR Percentile Rank falls between the measuring points, the Company's Relative TSR Percentile Rank will be rounded to the nearest whole percentage point. With respect to the Index Constituent Companies, such Initial Price and Final Price shall be determined on a component basis (assuming dividend reinvestment) during the applicable twenty (20) trading day periods using an open approach).

7. The companies included from the Russell 2000 Index for purposes of the Relative TSR Percentile Rank calculation (the "**Index Constituent Companies**") will be determined on the first day of the Measurement Period and will be changed only in accordance with the following and no company shall be added during the Measurement Period for purposes of the Relative TSR Percentile Rank calculation. The Index Constituent Companies for purposes of the Relative TSR Percentile Rank calculation will be subject to change as follows:

(i) In the event of a merger, acquisition or business combination transaction of a company in the Index Constituent Companies in which the company in the Index Constituent Companies is the surviving entity and remains publicly traded, the surviving entity shall remain a company in the Index Constituent Companies. Any entity involved in the transaction that is not the surviving company shall no longer be a company in the Index Constituent Companies.

(ii) In the event of a merger, acquisition or business combination transaction of a company in the Index Constituent Companies, a "going private" transaction or other event involving a company in the Index Constituent Companies or the liquidation of a company in the Index Constituent Companies, in each case where the company in the Index Constituent Companies is not the surviving entity or is no longer publicly traded, the company shall no longer be a company in the Index Constituent Companies.

(iii) Notwithstanding the foregoing, in the event of a bankruptcy of a company in the Index Constituent Companies where the company in the Index Constituent Companies is not publicly traded at the end of the Measurement Period, such company shall remain a company in the Index Constituent Companies but shall be deemed to have a Total Shareholder Return of negative 100% (-100%).

Award Number: _____

HARVARD BIOSCIENCE, INC.
2021 INCENTIVE PLAN

RESTRICTED STOCK UNIT AGREEMENT

1. Grant of Restricted Stock Units. Harvard Bioscience, Inc., a Delaware corporation (the "Company"), hereby grants to the Participant (the "Participant") named in the Notice of Restricted Stock Unit Award (the "Notice"), the number of restricted stock units ("Restricted Stock Units" or "RSUs") indicated in the Notice, subject to the terms and provisions of the Notice, this Restricted Stock Unit Award Agreement (this "RSU Agreement") and the Company's 2021 Incentive Plan (as amended from time to time, the "Plan"), which are incorporated herein by reference. Capitalized terms used but not defined herein shall have the meaning ascribed to them in the Plan.

2. Company's Obligation to Pay. Each Restricted Stock Unit represents the right to receive upon vesting thereof one share of Stock subject to Participant satisfying any applicable tax withholding obligations. Any Restricted Stock Units that vest in accordance with Section 3 will be settled in shares of Stock as soon as practicable after vesting, but in all cases within thirty (30) business days following the vesting date. Unless and until the Restricted Stock Units will have vested in the manner set forth in the Notice and the Plan, Participant will have no right to payment of any such Restricted Stock Units.

3. Vesting Schedule. Except as specifically provided in Sections 4 and 5 below, the Restricted Stock Units awarded by the Notice and this RSU Agreement will vest in accordance with the "Vesting Schedule" and Schedule A set forth in the Notice.

4. Termination of Employment; Retirement. Except as set forth in this Section 4 and in Section 5 below, the Participant's rights to all RSUs granted herein and not yet vested in accordance with the "Vesting Schedule" and Schedule A set forth in the Notice shall automatically terminate upon the Participant's termination of employment with the Company and its Subsidiaries for any reason.

    a. Death or Disability. In the event of the Participant's death or Disability while employed by the Company, the number of RSUs constituting the Target Award shall be adjusted upon the Participant's death or Disability by multiplying the then current number of RSUs constituting the Target Award effective immediately prior to the Participant's death or Disability by the number of full months elapsed from the Date of Grant to the date of Participant's death or Disability divided by 36.

    b. Rule of 65. In the event that the Participant has satisfied the Rule of 65 at the time of his or her termination of employment and such termination of employment is not for Cause, then the number of RSUs constituting the Target Award shall be adjusted upon such termination of employment by multiplying the then current number of RSUs constituting the Target Award effective immediately prior to such termination of employment by the number of full months elapsed from the Date of Grant to the date of such termination of employment divided by 36.

    c. Termination for Good Reason. In the event that the Participant's employment is terminated by the Participant for Good Reason, then the number of RSUs constituting the Target Award shall be adjusted upon such termination of employment by multiplying the then current number of RSUs constituting the Target Award effective immediately prior to such termination by the number of full months elapsed from the Date of Grant to the date of such termination of employment divided by 36.

5. Change in Control. Notwithstanding anything to the contrary in this Agreement, if a Change in Control occurs during the Performance Period, the date of such Change in Control shall be deemed the last day of the Performance Period, and the Performance Factor will be calculated as if the date of the Change in Control is the last day of the Performance Period. In such event, (i) the Participant's Final RSUs will be determined by multiplying the Target Award by the calculated Performance Factor and (ii) to the extent the achieved Performance Factor is greater than 0% as of the end of such reduced Performance Period, the Participant's Final RSUs shall vest in full as of the third anniversary of the Date of Grant, except that in the event the Participant's employment is terminated by the Participant for Good Reason or by the Company without Cause within one (1) year following such Change in Control or in the event of the Participant's death or Disability within one (1) year following such Change in Control, the RSUs shall automatically vest in full as of the date of such termination, death or Disability, as the case may be..

6. Transferability of RSUs. Unless determined otherwise by the Committee, the RSUs may not be sold, pledged, assigned, hypothecated, or otherwise transferred by Participant in any manner. Any shares of Stock acquired pursuant to this Award shall be held by the Participant and are not transferable for a period of one (1) year following the issuance of such shares.

7. Stop-Transfer Notices. In order to ensure compliance with the restrictions on transfer set forth in this RSU Agreement, the Notice or the Plan, the Company may issue appropriate "stop-transfer" instructions to its transfer agent, if any, and, if the Company transfers its own securities, it may make appropriate notations to the same effect in its own records.

8. Refusal to Transfer. The Company shall not be required (i) to transfer on its books any Shares that have been sold or otherwise transferred in violation of any of the provisions of this RSU Agreement or (ii) to treat as owner of such Shares or to accord the right to vote or pay dividends to any purchaser or other transferee to whom such Shares shall have been so transferred.

9. Tax Consequences.

    a. Participant is solely responsible for all federal, state and local taxes relating to the RSUs, including as a result of the Participant's disposition of the Shares.

    b. The Company makes no representation that the RSUs will comply with Sections 409A and 457A of the Code and makes no undertaking to prevent Section 409A or 457A of the Code from applying to the RSUs or to mitigate its effects on any deferrals or payments made in respect of the RSUs. The Participant is encouraged to consult a tax adviser regarding the potential impact of Section 409A and 457A of the Code.

10. Entire Agreement; Severability. The Notice, the Plan and this RSU Agreement constitute the entire agreement of the parties with respect to the subject matter hereof and supersede in their entirety all prior undertakings and agreements of the Company and the Participant with respect to the subject matter hereof, and may not be modified adversely to the Participant's interest except by means of a writing signed by the Company and the Participant. In the event of a conflict between the terms and conditions of the Plan and the terms and conditions of this RSU Agreement, the terms and conditions of the Plan shall prevail. Nothing in the Notice, the Plan and this RSU Agreement (except as expressly provided therein) is intended to confer any rights or remedies on any persons other than the parties. Should any provision of the Notice, the Plan or this RSU Agreement be determined to be illegal or unenforceable, such provision shall be enforced to the fullest extent allowed by law and the other provisions shall nevertheless remain effective and shall remain enforceable.

11. Construction. The captions used in the Notice and this RSU Agreement are inserted for convenience and shall not be deemed a part of the RSUs for construction or interpretation. Except when otherwise indicated by the context, the singular shall include the plural and the plural shall include the singular. Use of the term "or" is not intended to be exclusive, unless the context clearly requires otherwise.

12. Administration and Interpretation. Any question or dispute regarding the administration or interpretation of the Notice, the Plan or this RSU Agreement shall be submitted by the Participant or by the Company to the Committee. The resolution of such question or dispute by the Committee shall be final and binding on all persons.

13. Conflicts. In the event of a conflict or inconsistency between the terms and conditions of this RSU Agreement and another written agreement between the Company and the Participant that provides for accelerated vesting of the Participant's RSUs upon the occurrence of certain events, the terms and conditions of such other written agreement shall control.

14. Definitions. Whenever used in this Agreement, the following terms shall have the meanings set forth below.

    a. "Good Reason" shall have the meaning defined in the applicable employment agreement, consulting agreement or any other similar written agreement between the Participant and the Company (or any of its affiliates) that specifically defines "good reason," if any.

    b. "Rule of 65" means that the sum of the Participant's age and years of service equals or exceeds 65, with a minimum age of 55 and a minimum of five years of continuous service, including as an employee or a director of the Company.

Exhibit 10.18

HARVARD BIOSCIENCE, INC.
2021 INCENTIVE PLAN

NOTICE OF RESTRICTED STOCK UNIT AWARD

Participant Name and Address:

You (the "Participant") have been granted restricted stock units ("Restricted Stock Units" or "RSUs"), subject to the terms and conditions of this Notice of Restricted Stock Unit Award (the "Notice"), the Harvard Bioscience, Inc. 2021 Incentive Plan (as amended from time to time, the "Plan") and the Restricted Stock Unit Award Agreement (the "RSU Agreement") attached hereto, as follows. Unless otherwise defined herein, the terms defined in the Plan shall have the same defined meanings in this Notice.

Date of Grant:
Number of RSUs:
Vesting Schedule: Participant will receive a benefit with respect to an RSU only if it vests. Subject to the terms set forth in the RSU Agreement attached hereto, the RSUs will vest in accordance with the following schedule:

Vesting Date	Vesting Percentage
December 29, ____	33 1/3%
December 29, ____	33 1/3%
December 29, ____	33 1/3%

HARVARD BIOSCIENCE, INC.
By: _____
Name: _____
Title: _____

Award Number: _____

HARVARD BIOSCIENCE, INC.
2021 INCENTIVE PLAN

RESTRICTED STOCK UNIT AGREEMENT

1. Grant of Restricted Stock Units. Harvard Bioscience, Inc., a Delaware corporation (the "Company"), hereby grants to the Participant (the "Participant") named in the Notice of Restricted Stock Unit Award (the "Notice"), the number of restricted stock units ("Restricted Stock Units" or "RSUs") indicated in the Notice, subject to the terms and provisions of the Notice, this Restricted Stock Unit Award Agreement (this "RSU Agreement") and the Company's 2021 Incentive Plan (as amended from time to time, the "Plan"), which are incorporated herein by reference. Capitalized terms used but not defined herein shall have the meaning ascribed to them in the Plan.

2. Company's Obligation to Pay. Each Restricted Stock Unit represents the right to receive upon vesting thereof one share of Stock subject to Participant satisfying any applicable tax withholding obligations. Any Restricted Stock Units that vest in accordance with Section 3 will be settled in shares of Stock as soon as practicable after vesting, but in all cases within thirty (30) business days following the vesting date. Unless and until the Restricted Stock Units will have vested in the manner set forth in the Notice and the Plan, Participant will have no right to payment of any such Restricted Stock Units.

3. Vesting Schedule. Except as specifically provided in Sections 4 and 5 below, the Restricted Stock Units awarded by the Notice and this RSU Agreement will vest in accordance with the "Vesting Schedule" set forth in the Notice.

4. Termination of Employment; Retirement. Except as set forth in this Section 4 and in Section 5 below, the Participant's rights to all RSUs granted herein and not yet vested in accordance with the "Vesting Schedule" set forth in the Notice shall automatically terminate upon the Participant's termination of employment with the Company and its Subsidiaries for any reason.

    a. Death or Disability. In the event of the Participant's death or Disability while employed by the Company, a number of RSUs equal to one-third of the total number of RSUs granted pursuant to this RSU Agreement multiplied by the number of full months elapsed from the most recent Vesting Date to the date of Participant's death or Disability divided by 12 shall vest as of the date of the Participant's death or Disability.

    b. Rule of 65. In the event that the Participant has satisfied the Rule of 65 at the time of his or her termination of employment and such termination of employment is not for Cause, a number of RSUs equal to one-third of the total number of RSUs granted pursuant to this RSU Agreement multiplied by the number of full months elapsed from the most recent Vesting Date to the date of such termination of employment divided by 12 shall vest as of the date of such termination of employment.

    c. Termination for Good Reason. In the event that the Participant's employment is terminated by the Participant for Good Reason, a number of RSUs equal to one-third of the total number of RSUs granted pursuant to this RSU Agreement multiplied by the number of full months elapsed from the most recent Vesting Date to the date of such termination of employment divided by 12 shall vest as of the date of such termination of employment.

5. Change in Control. Notwithstanding anything to the contrary in this Agreement, in the event of a Change in Control and the Participant's employment is terminated by the Participant for Good Reason or by the Company without Cause within one (1) year following such Change in Control or in the event of the Participant's death or Disability within one (1) year following such Change in Control, the RSUs shall automatically vest in full as of the date of such termination, death or Disability, as the case may be.

6. Transferability of RSUs. Unless determined otherwise by the Committee, the RSUs may not be sold, pledged, assigned, hypothecated, or otherwise transferred by Participant in any manner.

7. Stop-Transfer Notices. In order to ensure compliance with the restrictions on transfer set forth in this RSU Agreement, the Notice or the Plan, the Company may issue appropriate "stop-transfer" instructions to its transfer agent, if any, and, if the Company transfers its own securities, it may make appropriate notations to the same effect in its own records.

8. Refusal to Transfer. The Company shall not be required (i) to transfer on its books any Shares that have been sold or otherwise transferred in violation of any of the provisions of this RSU Agreement or (ii) to treat as owner of such Shares or to accord the right to vote or pay dividends to any purchaser or other transferee to whom such Shares shall have been so transferred.

9. Tax Consequences.

    a. Participant is solely responsible for all federal, state and local taxes relating to the RSUs, including as a result of the Participant's disposition of the Shares.

    b. The Company makes no representation that the RSUs will comply with Sections 409A and 457A of the Code and makes no undertaking to prevent Section 409A or 457A of the Code from applying to the RSUs or to mitigate its effects on any deferrals or payments made in respect of the RSUs. The Participant is encouraged to consult a tax adviser regarding the potential impact of Section 409A and 457A of the Code.

10. Entire Agreement; Severability. The Notice, the Plan and this RSU Agreement constitute the entire agreement of the parties with respect to the subject matter hereof and supersede in their entirety all prior undertakings and agreements of the Company and the Participant with respect to the subject matter hereof, and may not be modified adversely to the Participant's interest except by means of a writing signed by the Company and the Participant. In the event of a conflict between the terms and conditions of the Plan and the terms and conditions of this RSU Agreement, the terms and conditions of the Plan shall prevail. Nothing in the Notice, the Plan and this RSU Agreement (except as expressly provided therein) is intended to confer any rights or remedies on any persons other than the parties. Should any provision of the Notice, the Plan or this RSU Agreement be determined to be illegal or unenforceable, such provision shall be enforced to the fullest extent allowed by law and the other provisions shall nevertheless remain effective and shall remain enforceable.

11. Construction. The captions used in the Notice and this RSU Agreement are inserted for convenience and shall not be deemed a part of the RSUs for construction or interpretation. Except when otherwise indicated by the context, the singular shall include the plural and the plural shall include the singular. Use of the term "or" is not intended to be exclusive, unless the context clearly requires otherwise.

12. Administration and Interpretation. Any question or dispute regarding the administration or interpretation of the Notice, the Plan or this RSU Agreement shall be submitted by the Participant or by the Company to the Committee. The resolution of such question or dispute by the Committee shall be final and binding on all persons.

13. Conflicts. In the event of a conflict or inconsistency between the terms and conditions of this RSU Agreement and another written agreement between the Company and the Participant that provides for accelerated vesting of the Participant's RSUs upon the occurrence of certain events, the terms and conditions of such other written agreement shall control.

14. Definitions. Whenever used in this Agreement, the following terms shall have the meanings set forth below.

    a. "Good Reason" shall have the meaning defined in the applicable employment agreement, consulting agreement or any other similar written agreement between the Participant and the Company (or any of its affiliates) that specifically defines "good reason," if any.

    b. "Rule of 65" means that the sum of the Participant's age and years of service equals or exceeds 65, with a minimum age of 55 and a minimum of five years of continuous service, including as an employee or a director of the Company.

Exhibit 10.19

HARVARD BIOSCIENCE, INC.
2021 INCENTIVE PLAN

NOTICE OF RESTRICTED STOCK UNIT AWARD

Participant Name and Address:

You (the "Participant") have been granted restricted stock units ("Restricted Stock Units" or "RSUs"), subject to the terms and conditions of this Notice of Restricted Stock Unit Award (the "Notice"), the Harvard Bioscience, Inc. 2021 Incentive Plan (as amended from time to time, the "Plan") and the Restricted Stock Unit Award Agreement (the "RSU Agreement") attached hereto, as follows. Unless otherwise defined herein, the terms defined in the Plan shall have the same defined meanings in this Notice.

Date of Grant:
Number of RSUs:
Vesting Schedule: Participant will receive a benefit with respect to an RSU only if it vests. Subject to the terms set forth in the RSU Agreement attached hereto, the RSUs will vest on the earlier of (i) immediately prior to the Company's next annual meeting of stockholders (so long as the date of such annual meeting is at least 50 weeks after the date of the immediately preceding year's annual meeting), and (ii) the first anniversary of Date of Grant.

HARVARD BIOSCIENCE, INC.
By: _____
Name: _____
Title: _____

Award Number: _____

HARVARD BIOSCIENCE, INC.
2021 INCENTIVE PLAN

RESTRICTED STOCK UNIT AGREEMENT

1. Grant of Restricted Stock Units. Harvard Bioscience, Inc., a Delaware corporation (the "Company"), hereby grants to the Participant (the "Participant") named in the Notice of Restricted Stock Unit Award (the "Notice"), the number of restricted stock units ("Restricted Stock Units" or "RSUs") indicated in the Notice, subject to the terms and provisions of the Notice, this Restricted Stock Unit Award Agreement (this "RSU Agreement") and the Company's 2021 Incentive Plan (as amended from time to time, the "Plan"), which are incorporated herein by reference. Capitalized terms used but not defined herein shall have the meaning ascribed to them in the Plan.

2. Company's Obligation to Pay. Each Restricted Stock Unit represents the right to receive upon vesting thereof one share of Stock subject to Participant satisfying any applicable tax withholding obligations. Any Restricted Stock Units that vest in accordance with Section 3 will be settled in shares of Stock as soon as practicable after vesting, but in all cases within thirty (30) business days following the vesting date. Unless and until the Restricted Stock Units will have vested in the manner set forth in the Notice and the Plan, Participant will have no right to payment of any such Restricted Stock Units.

3. Vesting Schedule. Except as specifically provided in Sections 4 and 5 below, the Restricted Stock Units awarded by the Notice and this RSU Agreement will vest in accordance with the "Vesting Schedule" set forth in the Notice.

4. Change in Control. Subject to Participant's continued service as a Director from the date of this Agreement until the consummation of a Change in Control, any RSUs that have not vested shall be deemed vested as of immediately prior to such Change in Control.

5. Termination. If Participant ceases to be a Director for any reason, whether voluntarily or involuntarily, any RSUs that have not vested shall be automatically forfeited, and any RSUs that have vested shall be retained by the Participant.

6. Transferability of RSUs. Unless determined otherwise by the Committee, the RSUs may not be sold, pledged, assigned, hypothecated, or otherwise transferred by Participant in any manner.

7. Stop-Transfer Notices. In order to ensure compliance with the restrictions on transfer set forth in this RSU Agreement, the Notice or the Plan, the Company may issue appropriate "stop-transfer" instructions to its transfer agent, if any, and, if the Company transfers its own securities, it may make appropriate notations to the same effect in its own records.

8. Refusal to Transfer. The Company shall not be required (i) to transfer on its books any Shares that have been sold or otherwise transferred in violation of any of the provisions of this RSU Agreement or (ii) to treat as owner of such Shares or to accord the right to vote or pay dividends to any purchaser or other transferee to whom such Shares shall have been so transferred.

9. Tax Consequences.

    a. Participant is solely responsible for all federal, state and local taxes relating to the RSUs, including as a result of the Participant's disposition of the Shares.

    b. The Company makes no representation that the RSUs will comply with Sections 409A and 457A of the Code and makes no undertaking to prevent Section 409A or 457A of the Code from applying to the RSUs or to mitigate its effects on any deferrals or payments made in respect of the RSUs. The Participant is encouraged to consult a tax adviser regarding the potential impact of Section 409A and 457A of the Code.

10. Entire Agreement; Severability. The Notice, the Plan and this RSU Agreement constitute the entire agreement of the parties with respect to the subject matter hereof and supersede in their entirety all prior undertakings and agreements of the Company and the Participant with respect to the subject matter hereof, and may not be modified adversely to the Participant's interest except by means of a writing signed by the Company and the Participant. In the event of a conflict between the terms and conditions of the Plan and the terms and conditions of this RSU Agreement, the terms and conditions of the Plan shall prevail. Nothing in the Notice, the Plan and this RSU Agreement (except as expressly provided therein) is intended to confer any rights or remedies on any persons other than the parties. Should any provision of the Notice, the Plan or this RSU Agreement be determined to be illegal or unenforceable, such provision shall be enforced to the fullest extent allowed by law and the other provisions shall nevertheless remain effective and shall remain enforceable.

11. Construction. The captions used in the Notice and this RSU Agreement are inserted for convenience and shall not be deemed a part of the RSUs for construction or interpretation. Except when otherwise indicated by the context, the singular shall include the plural and the plural shall include the singular. Use of the term "or" is not intended to be exclusive, unless the context clearly requires otherwise.

12. Administration and Interpretation. Any question or dispute regarding the administration or interpretation of the Notice, the Plan or this RSU Agreement shall be submitted by the Participant or by the Company to the Committee. The resolution of such question or dispute by the Committee shall be final and binding on all persons.

13. Conflicts. In the event of a conflict or inconsistency between the terms and conditions of this RSU Agreement and another written agreement between the Company and the Participant that provides for accelerated vesting of the Participant's RSUs upon the occurrence of certain events, the terms and conditions of such other written agreement shall control.

EXHIBIT 21.1

Subsidiaries Of Harvard Bioscience, Inc.

Name	Jurisdiction
AHN Acquisition GmbH	Germany
Asys Hitech GmbH	Austria
Biochrom Limited	United Kingdom
Biochrom US, Inc.	Delaware, United States
Biodrop Ltd.	United Kingdom
Cartesian Technologies, Inc.	Delaware, United States
CMA Microdialysis Ab	Sweden
Coulbourn Instruments, LLC	Delaware, United States
Data Sciences International, Inc.	Delaware, United States
Data Sciences (UK) Mn, Ltd.	United Kingdom
Data Sciences Eurl	France
Data Sciences GmbH	Germany
DSI (Shanghai) Trading Co Ltd.	China
Ealing Scientific Limited (DBA Harvard Apparatus, Canada)	Canada
FKA GSI US, Inc. (Formerly Genomic Solutions, Inc.)	Delaware, United States
FKA UBI, Inc. (Formerly Union Biometrica, Inc.)	Delaware, United States
Genomic Solutions Canada, Inc.	Delaware, United States
Harvard Apparatus, S.A.R.L.	France
Harvard Bioscience (Shanghai) Co. Ltd.	China
Harvard Distribution Oldco, Inc. (Formerly Denville Scientific, Inc.)	Delaware, United States
Heka Electronics Incorporated	Canada
Heka Electronik GmbH	Germany
Heka Instruments Incorporated	New York, United States
Hoefer, Inc.	Delaware, United States
Hugo Sachs Elektronik - Harvard Apparatus GmbH	Germany
KD Scientific, Inc.	Massachusetts, United States
Multichannel Systems MCS GmbH	Germany
Panlab S.L.	Spain
Scie-Plas Ltd.	United Kingdom
Triangle Biosystems, Inc.	Delaware, United States
Walden Precision Apparatus Ltd.	United Kingdom
Warner Instruments LLC	Delaware, United States

EXHIBIT 23.1

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We have issued our reports dated March 11, 2022, with respect to the consolidated financial statements and internal control over financial reporting included in the Annual Report of Harvard Bioscience, Inc. on Form 10-K for the year ended December 31, 2021. We consent to the incorporation by reference of said reports in the Registration Statements of Harvard Bioscience, Inc. on Forms S-8 (File No. 333-249943, File No. 333-53848, File No. 333-104544, File No. 333-135418, File No. 333-151003, File No. 333-174476, File No. 333-189175, File No. 333-204760, File No. 333-218497, File No. 333-225365, File No. 333-231825 and File No. 333-256295).

/s/ GRANT THORNTON LLP
Boston, Massachusetts
March 11, 2022

EXHIBIT 31.1

Certification

I, Michael A. Rossi, certify that:

1. I have reviewed this annual report on Form 10-K of Harvard Bioscience, Inc.;

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

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

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

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

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

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

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

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

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

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

Date: March 11, 2022

/s/ MICHAEL A. ROSSI
Michael A. Rossi
Chief Financial Officer

EXHIBIT 31.2

Certification

I, James Green, certify that:

1. I have reviewed this annual report on Form 10-K of Harvard Bioscience, Inc.;

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

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

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

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

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

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

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

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

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

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

Date: March 11, 2022

/s/ JAMES GREEN
James Green
Chief Executive Officer

EXHIBIT 32.1

CERTIFICATION OF PERIODIC FINANCIAL REPORT
PURSUANT TO 18 U.S.C. SECTION 1350

The undersigned officer of Harvard Bioscience, Inc. (the "Company") hereby certifies to his knowledge that the Company's annual report on Form 10-K for the year ended December 31, 2021 to which this certification is being furnished as an exhibit (the "Report"), as filed with the Securities and Exchange Commission on the date hereof, fully complies with the requirements of Section 13(a) or 15(d), as applicable, of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), and that the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company. This certification is provided solely pursuant to 18 U.S.C. Section 1350 and Item 601(b)(32) of Regulation S-K ("Item 601(b)(32)") promulgated under the Securities Act of 1933, as amended (the "Securities Act"), and the Exchange Act. In accordance with clause (ii) of Item 601(b)(32), this certification (A) shall not be deemed "filed" for purposes of Section 18 of the Exchange Act, or otherwise subject to the liability of that section, and (B) shall not be deemed to be incorporated by reference into any filing under the Securities Act or the Exchange Act, except to the extent that the Company specifically incorporates it by reference.

Date: March 11, 2022

/s/ MICHAEL A. ROSSI
Name: Michael A. Rossi
Title: Chief Financial Officer

EXHIBIT 32.2

CERTIFICATION OF PERIODIC FINANCIAL REPORT
PURSUANT TO 18 U.S.C. SECTION 1350

The undersigned officer of Harvard Bioscience, Inc. (the "Company") hereby certifies to his knowledge that the Company's annual report on Form 10-K for the year ended December 31, 2021 to which this certification is being furnished as an exhibit (the "Report"), as filed with the Securities and Exchange Commission on the date hereof, fully complies with the requirements of Section 13(a) or 15(d), as applicable, of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), and that the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company. This certification is provided solely pursuant to 18 U.S.C. Section 1350 and Item 601(b)(32) of Regulation S-K ("Item 601(b)(32)") promulgated under the Securities Act of 1933, as amended (the "Securities Act"), and the Exchange Act. In accordance with clause (ii) of Item 601(b)(32), this certification (A) shall not be deemed "filed" for purposes of Section 18 of the Exchange Act, or otherwise subject to the liability of that section, and (B) shall not be deemed to be incorporated by reference into any filing under the Securities Act or the Exchange Act, except to the extent that the Company specifically incorporates it by reference.

Date: March 11, 2022

/s/ JAMES GREEN
Name: James Green
Title: Chief Executive Officer