To: The U.S. Patent and Trademark Office, in response to your docket No. PTO–P–2021–0032
"Patent Eligibility Jurisprudence Study" via www.regulations.gov. October 15, 2021

Dear Andrew Hirshfeld,

Thank you for the opportunity to comment on the current state of patent eligibility jurisprudence and its impact on the United States.

When responding to the questions, please identify yourself and your interest in the U.S. patent system.

My interactions with the U.S. patent system span a long career. I appreciate patents as sources of scientific knowledge, as indicators and creators of business value, especially for newer and younger players in our innovation ecosystem, as a scholar, and as a citizen, in particular for their value as visible and expiring monopolies.

Since 2000, I have been a self-employed Boston based technology transfer practitioner, business development, licensing, and IP strategy consultant. Recent activities include finding, defining, and commercializing AI/ML innovations and inventions. Clients include companies, start-ups, nonprofit academic institutions and government organizations, I am a volunteer grant reviewer and mentor for various organizations, including the MIT Deshpande Center and MassVentures (START program).

I was a director of a publicly traded investment company from 2002-2012 (NASDAQ:TINY). I am an inventor[1]. I worked at the MIT TLO from 1989-2000, the last four years as assistant director with signatory authority. I was an engineer at Lasertron, an MIT start-up, from 1984-1989. Also in a technical role, I experienced the patent and inventor friendly environment of AT&T Bell Labs in the early 1980's.

I have been a reasonable royalty expert in patent damages litigation. I have published NIH funded research on patent policy[2] and studies estimating the economic impact of academic technology transfer using the Leontief I-O approach[3]. I have been a reviewer for the Patents for Humanity awards, and played various roles within AUTM (formerly the Association for University Technology Managers). I responded to PTO–C–2019–0029, and PTO–C–2019–0038.

I am not a lawyer. My degrees are SB, physics, MIT 1979, and MSEE, Columbia University 1983.

1. Please explain how the current state of patent eligibility jurisprudence affects the conduct of business in your technology area(s). Please identify the technology area(s) in your response.

My technology area is early technology when the value, or lack thereof, is less visible.

Uncertain patents reduce the ability of academic institutions to advocate for their inventors and their innovations, and risk creating cynicism among innovative scientists and engineers, who rightly observe that the system no longer makes sense.

Forcing a default to copyright, data rights and trade secrets disadvantages academic innovators in particular, as well as newer, less experienced and less wealthy-to-start innovators, and adds additional challenges to implementing multiparty collaborations.

Uncertain patents are an inefficiency machine, discouraging domestic start-ups and investors willing to work on projects with uncertain outcomes at precisely the time when the United States need them most.

2. Please explain what impacts, if any, you have experienced as a result of the current state of patent eligibility jurisprudence in the United States. Please include impacts on as many of the following areas as you can, identifying concrete examples and supporting facts when possible: a. Patent prosecution strategy and portfolio management; b. patent enforcement and litigation; c. patent counseling and opinions; d. research and development; e. employment; f. procurement; g. marketing; h. ability to obtain financing from investors or financial institutions; i. investment strategy; j. licensing of patents and patent applications; k. product development; l. sales, including downstream and upstream sales; m. innovation; and n. competition.

(2a) We are drafting and filing patent applications now for defensibility over enforceability. Defensibility favors mature players, enforceability favors newer players.

I have been told by patent counsel recently "be your own lexicographer" on key terms describing the invention. Explanations for why this is a good approach include the suggestion that applicant defined terms provide additional noninfringement arguments, should such arguments be needed.

A few years ago, the advice to patent applicants tended to be in the area of evidence, additional demonstration and reduction to practice. This advice of a few years ago seems fair and sporting to this engineer. "Be your own lexicographer" seems designed to add arguments to Markman hearings.

If we as a society are serious about increasing the demographic, geographic, and economic diversity of inventors and the companies that employ them to produce the new products we need, we have to return to a fact based process for obtaining clear, reasonably allowable and enforceable patents.

(2b). I continue to advise clients to prepare patent applications anticipating they may want to enforce the resulting patents at some point, and have found, recently, that my business advice does not agree entirely with patent counsel advice on this point. It may be that patent counsel sees issuance as more certain than enforcement.

(2.i and k). I observe that private investors are investing later in the process. They are waiting for more reduction to practice, demonstrations, and market and customer identification. I observe state governments and foundations funding more translational work, and have participated in state grant funding review committees. I observe and have participated in efforts to direct faculty and faculty start-ups to these other sources of funding, neither industrial, nor U.S. federal.

3. Please explain how the current state of patent eligibility jurisprudence in the United States impacts particular technological fields, including investment and innovation in any of the following technological areas: a. Quantum computing; b. artificial intelligence; c. precision medicine; d. diagnostic methods; e. pharmaceutical treatments; and f. other computer-related inventions (*e.g.*, software, business methods, computer security, databases and data structures, computer networking, and graphical user interfaces).

It is possible to innovate absent patents, and companies have the option of appropriating value, and keeping, trading, licensing or selling it at their discretion, via proprietary assets, such as trade secrets. Academic innovators do not realistically have trade secrets as an option, as described in AUTM's response to PTO-C-2019-0038[4] (Comments on Intellectual Property Protections for Artificial Intelligence Innovation) and to this question 3 in their response to PTO–P–2021–0032. Academic innovators can appropriate some value via copyright, know-how, and data, but various problems arise with this approach as described in the AUTM response to question of 3 PTO–P–2021–0032, and the comments in 12b of this response.

To the extent that we as a society believe public-private partnerships have an important role to play in sustaining and renewing the U.S. innovation ecosystem, then disempowering the academic actors is detrimental to all technical areas and to the U.S. as a whole.

The technological areas listed in this question 3 and in question 12 overlap with markets, and are applicable to many markets. For example, artificial intelligence is applicable to smart agriculture, materials engineering, and virtually any multivariate causation problem, including of course, discovering predictive and accurate multivariate diagnostic assays. And materials engineering is applicable to energy storage, carbon capture, biodegradable plastics, and a multitude of innovations needed to mitigate the effects of climate change. Quantum computing has

applications in chemistry and materials engineering as well as security, and thus also has the potential to help the chemists and materials scientists mitigate the effects of climate change.

7. Please explain whether the state of patent eligibility jurisprudence in the United States has caused you to change business strategies for protecting your intellectual property (*e.g.*, shifting from patents to trade secrets, or vice versa). If so, please identify the changes and their associated impacts.

I advise clients, including academic ones, to be sure not to only have a patent strategy, but also a plan for capturing business value via copyright and data rights. I urge new companies to build value by creating their own proprietary databases, including one which recently asked me to help them build their patent portfolio.

I observe growing interest among academic institutions to improve and embrace management of unpatented and unpatentable intellectual property, from copyrightable works, including images and software, to data and know-how. This remains a work in process as trade secrets do not align with the ethos of an academic environment, as discussed in AUTM's response to PTO-C-2019-0038.

8. Please explain whether you have changed your behavior with regard to filing, purchasing, licensing, selling, or maintaining patent applications and patents in the United States as a result of the current state of patent eligibility jurisprudence in the United States. If so, please describe how you changed your behavior.

It has become a best and necessary practice to have stepped royalty provisions in patent license agreements which cover the situation where the licensed products no longer read on the licensed patents under various circumstances.

Certainly some of the time these Kimble v Marvel compliant contract terms exist for business reasons alone, everything from product development times which are expected to exceed patent life, or the reverse, that the product is expected to evolve out from under the patent claims very quickly, and the parties wish to strike a deal where amortized payments go to the patent holder for a period of time because the teachings in the patents and or other associated intellectual property, such as tangible materials, copyrightable works, know-how and data contributed to the product in question.

However, there are now additional reasons to include such Kimble v Marvel compliant language, namely that the patent's existence and durability are in jeopardy from the start due to unclear and uncertain patent jurisprudence. That said, it is important not to underestimate the value of the patent to the licensor, as it helps them attract and then negotiate with the licensee. It also is, or was, a third party validation of the technology in question. The licensor and licensee both know that at least one patent examiner found the disclosed invention novel, and not obvious to one of ordinary skill in the art.

10. Please identify how the current state of patent eligibility jurisprudence in the United States impacts the global strength of U.S. intellectual property.

It is not clear if patent applications will issue at all or if they do, if they will be enforceable. Uncertainty creates weak patents. Weak patents reduce the appeal of the U.S. as a place to invest, and of U.S. inventions as an asset worthy of investment. As noted by Taylor in his survey on patent eligibility and investment:

> "The survey results reveal investors' overwhelming belief that patent eligibility is an important consideration in investment decision making, and that reduced patent eligibility makes it less likely their firms will invest in companies developing technology." [5]

Weak patents reduce the appeal for parties other than the direct beneficiaries of research to fund the research. Weak patents push sponsored research, where the funder and performer are more inclined to share resources and results, into work for hire. Consequently, it damages partnerships in general and public-private partnerships in particular.

Weak patents force the U.S. into more of a trade secret regime, with the attendant administrative, legal[6], and security costs. Because of these additional transaction costs, it damages newer and younger actors of all types, both new companies and new inventors, and especially academic inventors. By disadvantaging newer and younger participants, unpredictably allowable and unpredictably enforceable patents will harm, not help our efforts to create a more demographically, economically, and geographically diverse innovation ecosystem.

A weak patent system places the U.S. at a disadvantage with respect to recruiting and retaining intellectual capital, and with respect to nurturing the next generation of domestic start-ups. More than seventy percent of the more than fifteen thousand U.S. start-ups reported to the AUTM Survey between 1997-2020 are located in the home state of the founding institution.

11. Please identify how the current state of patent eligibility jurisprudence in the United States impacts the U.S. economy as a whole.

Weak patents are an inefficiency machine. Patent uncertainties damage AUTM members' ability to work with the private sector, at least for the same stage of maturity of the technology. It greatly reduces their clout at the bargaining table, including their ability to advocate for their inventors, the technology they develop, and the domestic start-ups they want to found or join.

Wobbly patents effectively turn more industry sponsored academic research into work for hire. Frequently, the industry sponsored research terms provide the sponsor a royalty free non-exclusive license, with no further contractual obligations to develop the technology. Industry sponsored research terms often also include the right to negotiate for a royalty bearing exclusive license, subject to contractual requirements to develop the technology, thus, incentivizing the development and distribution of the technology. When meaningful exclusivity is not possible a collaborative public-private partnership opportunity is often lost.

BIO and AUTM publish an estimate of the economic impact of AUTM member technology transfer activity. According to the most recent report, released in 2019[7], over a 22 year period from 1996-2017, public-private partnerships, and the intellectual property and patent licenses associated with such partnerships, contributed, in 2012 dollars, up to $1.7 trillion to US Gross Industrial Output, up to $865 billion to GDP, and supported up to 5.9 million person years of employment.

AUTM data suggest that our community (nonprofit research institutions and our inventors and our licensees) contributed disproportionately to US GDP growth as a whole over a 21 year period from 1997-2017. U.S. GDP grew, on average, a little over 2% per year between 1997 and 2017. Research intensive industries[8], [9] grew, on average a little over 4% per year over the same time period. The sales of new products reported under the AUTM Survey, and captured in the BIO and AUTM report released in 2019 grew on a par with the research intensive industries.

Virtually all products reported under the AUTM Survey are new products, as such products age out of reporting requirements. The fact that the growth rate[10] (not the absolute number, please see endnote) of the AUTM licensees' modeled contribution to GDP closely tracks (and for selected sectors and time periods may exceed) the growth rate of research intensive industries' contribution to GDP underscores the importance of new products to GDP.

New product sales add to, replace, and/or prevent a loss of existing revenue streams. Thus, new product development also supports preservation of current productivity, manufacturing and jobs, and as such has a role to play in enhancing U.S. competitiveness.

Unclear patent law places an undue burden on these high growth industries and the public-private partnerships that support and benefit from them.

Entrepreneurially inclined academics consider technology transfer and entrepreneurship environments when they are choosing a home institution. Some well know U.S. academics have changed institutions, in part due to the perception that certain environments are more conducive to entrepreneurial activity, or to ensuring the distribution and thus impact of their work. This trend could continue, leading to more international moves as well as moves with in the U.S., thus depriving the U.S. of talent.

Unclear patent law places an undue burden on talented innovators, -who will go where the rules make sense, and investors will meet with them, literally, and figuratively, sooner.

12. Please identify how the current state of subject matter eligibility jurisprudence in the United States impacts the global strength of U.S. intellectual property and the U.S. economy in any of the following areas: a. Quantum computing; b. artificial intelligence; c. precision medicine; d. diagnostic methods; e. pharmaceutical treatments; and f. other computer-related inventions (*e.g.*, software, business methods, computer security, databases and data structures, computer networking, and graphical user interfaces).

These comments are to some degree informed by the remarks[11] of Laurie Self, Senior Vice President, Qualcomm, to Senators Tillis and Hirono, including the discussion of 101 and 112. In general, uncertainty reduces value, encourages work arounds, and reduces a potential U.S. competitive advantage. Impacts across fields are more pronounced at academic institutions and at smaller and newer companies for the reasons discussed above.

I will not attempt to calculate losses, past, present, and future, due to the particular problems introduced by unclear patent law in the technological areas identified in questions 3 and 12 of the RFI. Instead I will discuss the impact on particular groups of technological areas, markets, and on us.

a. Quantum computing, designs of leading edge hardware, and novel materials:

Quantum computing will contribute to cybersecurity overall, and to solving previously intractable problems, such as modeling and predicting chemical reactions. It may itself be a research efficiency driver. Quantum computing depends on quantum entanglement which is a natural phenomenon, and uses qubits, which could be considered products of nature.

Will hardware designs that exploit a natural phenomenon, including, for example quantum entanglement, run afoul of 101? Will leading edge hardware inventors be able to claim ranges of design specifications, or only the machine that they built? Will enablement become overly field specific, subject to unpredictable 101 interpretation, or will it be amenable to the customary 112 requirement, that a person of skill in the relevant art could practice the claimed invention without undue experimentation based on the specification at the time of filing?

The results of preventing innovators from claiming the range of specifications that they discover produces a useful result will reduce public-private partnerships and add inefficiencies to these maturing and vital industries. In view of American Axle decision, these concerns are real, and impact other leading edge hardware designs and material innovations inspired by an understanding of the underlying physics. Practical applications include high temperature superconductors, batteries, distributed energy storage and carbon capture.

b. artificial intelligence and f. other computer-related inventions

AI inventions risk being found not patent eligible, or later invalidated, under the “abstract idea” exception, even when practical results are obtained, and the process for obtaining the results has been disclosed. On the surface, AI and computer innovators could elect to use other forms of IP protection, such as copyrighted software, or copyrightable elements within data sets.

However, it is relatively easy to design around or rewrite code entirely, particularly for entities with significant resources. Copyright protection may provide a head start, but rarely a sustainable competitive advantage. Know-

how can be licensed non-exclusively, consistent with the academic mission. Know-how alone is also unlikely to be a compelling nugget around which a company can be formed or a new product developed.

For profit entities can opt to use trade secrets, an alternative not available to academic inventors. Innovators in the biological sciences can sometimes use tangible biological materials as technology transfer tools. This option is not available to AI and software innovators.

That said, AI inventors, frustrated by the challenge of interpreting the "abstract" idea exception, are turning to development of proprietary training sets, including seeking corporate funding to develop such training sets. Others leave academia altogether, creating, ironically, a shortage of AI faculty[12]. One of the suggestions to address this academic brain drain is to encourage faculty and students to launch start-ups, -made more challenging of by the lack of an identifiable and predictable scope of intellectual property protection. AI is applicable to virtually every field, from drug discovery and materials engineering, to smart agriculture, remote sensing and self driving cars. It is also considered an essential foundation of our national security.[13]

c. precision medicine;
If "precision medicine" means "diagnostic methods" then see the entire diagnostic methods section below, including the background section, and the section on wellness biomarkers. If "precision medicine" means therapies designed for particular groups of people, then see in particular, the discussion of patient selection biomarkers.

There are other therapies which may be impacted by 101 considerations, such as controlled, sterile, microbiome compositions, which may act to restore a more normal microbiome, or make a patient more likely to respond to certain other therapies. Will such compositions be treated as Takimine's "isolated adrenaline" was under Parke-Davis, or as protein coding nucleic acid sequences were in Myriad?

d. diagnostic methods; and e. pharmaceutical treatments;
Background:
Patent claims which require two actions to cause infringement, such as is currently the case in the U.S. for so called "diagnostic method" claims, where both the characterization of the patient sample and the intervention are recited in the same claim, are essentially unenforceable, as one entity would typically characterize the sample, and another would base the intervention on the result. Neither entity practices the claim in full, thus avoiding infringement. In contrast, claims on characterizing the sample alone and silent with respect to the intervention are patent eligible and enforceable in jurisdictions outside the U.S, including Europe[14] and Canada[15].

It is particular distressing to see discoveries on biomarkers virtually removed from the scope of patent eligible subject matter in the United States, when there is such clear medical value. The value falls in several categories, a) more efficient clinical trials or therapeutic development, b) reduced use of, or rational opting out from, unnecessary procedures and treatments, and c) incentivizing broad availability and use of such wellness biomarkers, in contract to therapeutic indication biomarkers.

Patient Selection Biomarkers.(Companion diagnostics): Data from Project Alpha at the MIT Sloan School track the probability of approval of pharmaceuticals with and without patient recruitment biomarkers[16]. Overall, investigational new drugs with biomarkers are two to three times as likely to be approved as those without biomarkers. In oncology, drugs with biomarkers are *ten times* as likely to be approved as those without. A substantial fraction of the one billion plus dollars[17] per new FDA approved drug goes to support the projects that fail. Imagine if the single digit likelihood of success for oncology drug candidates improved by a factor of ten.

In the current environment, companies that develop therapeutics derive the primary benefit from biomarker discovery and validation, yet their development incentives are only partly aligned with those of patients. Patient selection biomarkers can increase the probability of drug approval and reimbursement while also reducing the

overall market size. Also, doing a trial to validate a biomarker can take significant effort, in one study, apparently as long as trials for therapeutics[18]. Thus, companies don't always start drug trials with a biomarker, and move to biomarker recruitment trials when a drug is already in development and perhaps not showing a pronounced enough beneficial effect.

Wellness biomarkers: Some biomarkers, such as Exact Sciences'Cologuard® or Genomic Health's OncotypeDx® and can be used to guide rational use of medical interventions, including opting out of treatments or procedures. Their beneficiaries are essentially patients and insurance companies. Exact Sciences was founded in 1995, and Genomic Health in 2000.Both had long journeys to market acceptance, insurance reimbursement, and profitability, and merged in 2019. The scope of available patent protection has changed considerably since then, and hard to imagine that a new stand alone diagnostic company is fundable in the U.S. today.

Biomarkers can and do lead to their own insights into health and disease, and can, of course, create hypotheses leading to new and improved therapeutics. Reinstating biomarkers as a class of patent eligible subject matter should also have a positive impact on drug repurposing, -or development of combination therapies, leading to more efficient use of existing resources. Leaving incentives for biomarker discovery and development solely to pharmaceutical companies with a drug already in hand is not ideal, as it undervalues both patient choice and efficient healthcare delivery.

13. Please identify how the current state of patent eligibility jurisprudence in the United States affects the public. For example, does the jurisprudence affect, either positively or negatively, the availability, effectiveness, or cost of personalized medicine, diagnostics, pharmaceutical treatments, software, or computer-implemented inventions?

Uncertain patents put the public-private partnerships that support innovation and sustain U.S. productivity at risk.

Sincerely,
Lori Pressman

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[1] US 10492876 "Devices And Methods For Laser Surgery", by Anastassiou, Charalambos; Fuflyigin, Vladimir;. Graham, Marc; Josephy, Noam; Le, Thieu, L.; Malhi, Arnaz Singh; Payne, Robert; Pressman, Lori; .Rusk, Jesse; Shapira, Gil; Shurgalin, Max; Simon, Crystal;

US 9063299: "Two-Part Surgical Waveguide" by Max Shurgalin, Vladimir Fuflyigin, Douglas Woodruff, Mihai Ibanescu, Lori Pressman, Charlambos Anastassiou, Soura Bhattacharyya, and Yoel Fink.

US 7190875 "Fiber Waveguide Formed from Chalcogenide Glass and Polymer" by Emilia Anderson, Wesley A. King, Yoel Fink, and Lori Pressman

US 7142756 "High Index-Contrast Fiber Waveguides and Application" by Emilia Anderson, Wesley A King, Yoel Fink, and Lori Pressman

US 6898359 "High Index-Contrast Fiber Waveguides and Applications" by Marin Soljacic**,** Mihai Ibanescu, Torkel Engeness, Maksim Skorobogatiy, Steven G. Johnson, Ori Weisberg, Yoel Fink, Rokah U. Ahmad, Lori Pressman, Wesley A. King, Emilia Anderson, John.S. Joannopoulos

US 6801698 "High Index-Contrast Fiber Waveguides and Applications" by Wesley A. King, Emilia Anderson, Marin Soljacic, Mihai Ibanescu, Torkel Engenes, Maksim Skorobogatiy, Steven G. Johnson, Ori Weisberg, Yoel Fink, Rokan U. Ahmad, Lori Pressman

US 6788864: "High Index-Contrast Fiber Waveguides and Applications" by Rokan U. Ahmad, Marin Soljacic,Mihai Ibanescu,Torkel Engeness, Maksim Skorobogatiy, Steven G. Johnson, Ori Weisberg, Yoel Fink, Lori Pressman, Wesley A. King**,** Emilia Anderson, John D. Joannopoulos.

Prosecution discontinued: US20150202005A1 "System and Method to Control Surgical Energy Devices" by Vladimir Fuflyigin and Lori Pressman

[2] Lori Pressman "DNA Patent licensing under two policy frameworks: Implications for patient access to diagnostic tests and licensing practice in the not for profit sector", *BNA Life Sciences Law and Industry Report*, March 23, 2012

Lori Pressman, Richard Burgess, Robert M. Cook-Deegan, Stephen J. McCormack, Io Nami-Wolk, Melissa Soucy, and LeRoy Walters, "Patenting and Licensing Practices for DNA-Based Patent at U.S. Academic Institutions" *Nature Biotechnology*, January 2006

[3] Lori Pressman, Mark Planting, Jennifer Bond , Robert Yuskavage, and Carol Moylan "The Economic Contribution of University/Nonprofit Inventions in the United States 1996 – 2017". Commissioned by BIO and AUTM, released June 2019

Lori Pressman. "Theoretical and Empirical Approaches to Quantitatively Valuing Research." *Theoretical Issues in Ergonomics Science* 20, no. 1 (February 2019): 8–26.

[4] (Docket No. PTO-C-2019-0038) https://autm.net/AUTM/media/About-Tech-Transfer/Documents/AUTM-Comments-on-Intellectual-Property-Protections-for-Artificial-Intelligence-Innovations_1-10-20.pdf

[5] Taylor, David O., Patent Eligibility and Investment (February 24, 2019). 41 Cardozo Law Review 2019 (2020), SMU Dedman School of Law Legal Studies Research Paper No. 414, Available at SSRN: https://ssrn.com/abstract=3340937 or http://dx.doi.org/10.2139/ssrn.3340937

[6] https://news.bloomberglaw.com/ip-law/costs-soar-for-trade-secrets-pharma-patent-suits-survey-finds "The costs of litigating multimillion-dollar trade secrets and pharmaceutical cases have spiked over the past four years, even as the price of overall patent litigation has plummeted, an American Intellectual Property Law Association report shows"

[7] Pressman, Lori and Planting, Mark A. and Bond, Jennifer and Yuskavage, Robert and Moylan, Carol E., The Economic Contribution of University/Nonprofit Inventions in the United States: 1996 – 2017 (June 2, 2019). https://autm.net/AUTM/media/About-Tech-Transfer/Documents/Economic_Contribution_Report_BIO_AUTM_JUN2019_web.pdf

[8] Carol A. Robbins and Carol E. Moylan, 2007, "Research and Development Satellite Account Update: Estimates for 1959–2004, New Estimates for Industry, Regional, and International Accounts," ***Survey of Current Business*** 87 (October): 49–92. https://apps.bea.gov/scb/pdf/2007/10%20October/1007_rd_text.pdf

[9] Wendy C. Y. Li and Bronwyn Hall, 2018, "Depreciation of Business R&D Capital," *Review of Income and Wealth*, DOI: 10.1111/roiw.12380, https://onlinelibrary.wiley.com/doi/10.1111/roiw.12380.

[10] The absolute contribution of products reported under the AUTM survey to U.S. GDP as a whole is of course small, on the order of a few tenths of a percent. For context, the modeled contribution of such products to GDP in 2017 was $43.5 billion in 2012 dollars, while U.S. GDP as a whole in 2017 was $18.1 trillion in 2012 dollars. For context, the seven research intensive industries used in the 2019 BIO/AUTM report, alone, contributed about 13% to U.S. GDP as a whole in 2017. See especially figure 4 of the 2019 report (ft 3 above), and table S-7.

[11] https://www.judiciary.senate.gov/imo/media/doc/Self%20Testimony.pdf and https://www.judiciary.senate.gov/imo/media/doc/Self%20Responses%20to%20Questions%20for%20the%20Record.pdf

[12] https://www.insidehighered.com/views/2019/11/20/how-stop-brain-drain-artificial-intelligence-experts-out-academia-opinion

[13] https://www.nscai.gov/wp-content/uploads/2021/03/Full-Report-Digital-1.pdf

[14] https://www.epo.org/law-practice/legal-texts/html/guidelines/e/g_ii_4_2_1_3.htm Note that "methods for merely obtaining information (data, physical quantities) from the living human or animal body (e.g. X-ray investigations, MRI studies, and blood pressure measurements) are not excluded from patentability under Art. 53(c)."

[15] https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr04861.html See diagnostic method example

[16] https://projectalpha.mit.edu/pos/ See "Estimates of PoS, Biomarkers – 2021Q2 Update"

[17] https://pubmed.ncbi.nlm.nih.gov/26928437/ DiMasi JA, Grabowski HG, Hansen RW. Innovation in the pharmaceutical industry: New estimates of R&D costs. J Health Econ. 2016 May;47:20-33; and

https://pubmed.ncbi.nlm.nih.gov/32125404/ Wouters OJ, McKee M, Luyten J. Estimated Research and Development Investment Needed to Bring a New Medicine to Market, 2009-2018. JAMA. 2020 Mar 3;323(9):844-853.

[18] https://pubmed.ncbi.nlm.nih.gov/29394327/ Wong, Chi Heem, Kien Wei Siah, and Andrew W. Lo. 2018. "Estimation of Clinical Trial Success Rates and Related Parameters.". *Biostatistics* (2019) 20, 2, *pp.* 273–286. See page 280, excerpt:
However, when we expanded the definition of a biomarker trial to include trials with the objective of evaluating or identifying the use of any novel biomarker as an indicator of therapeutic efficacy or toxicity, in addition to the selection of patients, we obtained significantly different results (see Table S3 in Section A6 of the supplementary material available at Biostatistics online). Instead of finding a huge increase in the overall POS, we find no significant difference. It may be that trials that attempt to evaluate the effectiveness of biomarkers are more likely to fail, leading to a lower overall POS compared to trials that only use biomarkers in patient stratification. Comparison of the two tables shows that new biomarkers are being evaluated in all therapeutic areas. We provide a more detailed analysis of the differences between our analysis and Thomas and others (2016) in Section A7 of the supplementary material available at Biostatistics online.