Produced July 2019
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**BenchSci (BenchSci Analytics Inc.)**
www.benchsci.com

## Introduction

BenchSci is an AI based reagent intelligence platform focusing on antibodies that transforms published data into experiment-specific recommendations to reduce time, money, and uncertainty in planning materials and methods. With antibodies being one of the most commonly used research reagents (88%), the platform has wide usage in life sciences (particularly R&D) and has a major application within drug discovery and development. In short the platform has the ability to allow anyone who is involved with proteins to know what antibody (Ab) to use and why.

The Toronto based startup was initially founded in 2015 by Tom Leung (CSO) while a PhD candidate initially recruiting David Chen (CTO), Elvis Wianda (CDO) with Liran Belenzon (CEO) joining roughly 1 year. All but Liran have PhDs and have spent “time on the bench” along with having a scientific background, making this truly a user focused product.

## Funding

BenchSci has raised a total of CAD $27.2M[1] (USD $20.5M) in funding to date (Series A) from Gradient Ventures (Google), iNovia Capital, 500 Startups, Golden Gate Ventures, Afore Capital, Radical Ventures along with various grants. BenchSci initially raised a CAD $250,000 pre-seed, followed by a seed round of CAD $2.5M and CAD $7.3M in venture debt. BenchSci also participated in Creative Destruction Lab (CDL-Toronto[2]), the Entrepreneurship Hatchery[3] and the Health Innovation Hub (H2i).

## Competition

There are a few direct competitors as well as several, potential and indirect competitors which are:

- Direct Antibody Search Engine: CiteAb, Lindscott’s Directory, Antibody Advisor, Antibodypedia, Antibody Registry, Labome
- Indirect Specific Marketplaces (with databases): Antibodies.com, Antibodies-online, Biocompare, BIOZOL, IHC World
- AI Research Tools: BenvolentAI (BenvolentBIO), Bioz
- Research DB/Search Engines: Google (Google Scholars), Elsevier (Science Direct), ResearchGate, JSTOR, Biological Abstracts, BioOne, PubMed, Biocompare, SPRESI
- Antibody Manufacturers (large cap & common)[4]: Thermo Fisher Scientific (eBiosciences, invitrogen, Fisher Scientific), Agilent (Dako), BD (BD Biosciences), Merck KGaA (EMD Millipore, MilliporeSigma, Sigma Aldrich), Abcam, Roche, Bio-Techne (R&D Systems, Novus Biologicals), Bio-Rad Laboratories (Bio-Rad Ab, AbD Serotec)
- Antibody Manufacturers (small & uncommon): Santa Cruz Biotechnology, Cell Signaling Technology, LifeSpan BioSciences, StressMarq Biosciences, Proteintech
- Life Sciences ECommerce Platforms: Quartzy, LabClinics, scientist.com, Science Exchange

[1] https://www.pehub.com/canada/2019/06/googles-gradient-ventures-tops-up-BenchScis-funding-to-27-2-mln/
[2] https://www.creativedestructionlab.com/program
[3] https://hatchery.engineering.utoronto.ca/team/scinapsis
[4] https://www.labome.com/method/Antibody-Companies.html

There are a few competitors to BenchSci's core product as of June 2019 in the antibody space (namely CiteAb), however as BenchSci grows there will be several verticals in and other markets particularly into antibody manufacturing and life sciences ecommerce that BenchSci can and will eventually compete in. However, BenchSci may be the only company that solves the question "what" antibody should I use today.

## Key Risks

### Revenue Model

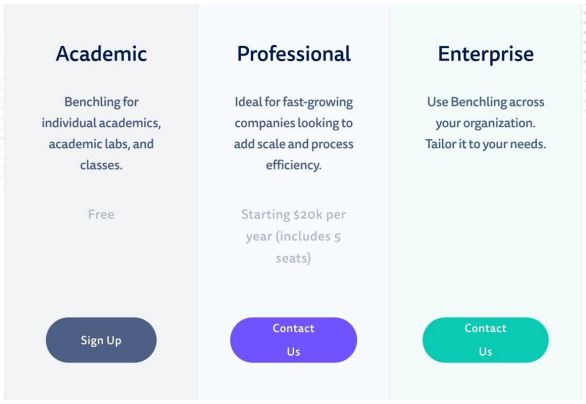
Currently BenchSci has 2 tiers one for academic (where you need an .edu email to signup) and an enterprise version (with a few more features). It may seem the bulk majority of the users might be education. Further it is unknown what the exact cost are (monthly or yearly + per seat user).


BenchSci offers several additions for the enterprise clients (from the website) such as[5]:

- Enterprise-wide license enabling domain-based employee login
- Registration and login integrations enabling seamless single sign-on
- Workflow integrations including links from intranet and e-procurement tools
- Enterprise-grade security and privacy including SOC 2 Type 2 certification and customer-specific data policies
- Onsite and virtual training customized to audience needs including therapeutic area
- Chat- and email-based antibody selection support including target and filter guidance
- Dedicated account management including account executive, customer success manager, and scientific liaisons

A similar company Benchling, has 3 pricing structure. It is hypothesized that Professional would costs $20,000 per year for up to 5 users and the Enterprise would cost +20K for 5 users.

[5] https://www.benchsci.com/pricing




**Growing Trend of AI (in Drug Discovery)**

The huge opportunities presented by the application of AI in the pharma industry come with challenges — not just with the technology, but with the data and the way work is still conducted. The pharma companies still must be convinced that investing in AI technologies will provide value and then have sufficient knowledge to select the technologies most appropriate to the specific applications they are considering.

As of 2019, there is still a lack by pharmaceutical researchers in the expertise in data science and thus an understanding of the potential benefits that AI can bring. In a 2018 survey[6] conducted (by BenchSci) consisting of 330 drug-discovery scientists, +40% of respondents said they were unfamiliar with potential applications of AI, along with lacking the knowledge of both the technology and the companies offering AI tools and services. Nonprofit innovation advocate the Pistoia Alliance similarly found in a separate survey of 374 life scientists that lack of expertise is seen as the top barrier preventing wider adoption of AI.

**Contents**



[6] https://www.forbes.com/sites/forbestechcouncil/2018/02/02/the-top-barrier-to-ai-in-drug-discovery-may-surprise-you/#41bb06d44fd1

**Summary**

Founded in 2015 by a team of PhD (specializing in biology) in Toronto and officially launched July 2017. BenchSci's mission is to "Empower the World's Scientists to Run More Successful Experiments to Accelerate Drug Discovery", by using machine learning to translate both closed- and open-access data into recommendations for specific experiments that a researcher is planning to carry out. Its first product is the AI-assisted antibody selection platform.

**Business**

1. BenchSci is developing an AI-Assisted Antibody Selection Platform, in which the key features are:
    - Easily search by protein target
    - Filter by technique and 16 other experimental variables including organism, tissue, cell type, cell line, and disease
    - Select experiment-specific antibodies in minutes
    - Access to the world's largest antibody database

**Market**

1. BenchSci provides a turnkey, customer-validated solution to the failure of scientific experiments (industry-wide problem) which delays drug discovery projects by weeks to months often due to the selection of inappropriate reagents.

**Users and/or Partners**

1. Unnamed and but cited that majority of the top 10 pharma companies use BenchSci
2. +26K users at +2K academic institutions

**Financials**

1. BenchSci raised USD $10M series A, led by iNovia Capital with Gradient Ventures with additional investors Real Ventures, Golden Ventures, and Afore Capital participating bringing the total funding of CAD $27.2M.

**Competition**

1. Direct Antibody Search Engine: CiteAb, Lindscott's Directory, Antibody Advisor, Antibodypedia, Antibody Registry, Labome
2. Indirect Specific Marketplaces (with databases): Antibodies.com, Antibodies-online, Biocompare, BIOZOL, IHC World
3. Indirect DB/Search Engines: Google (Google Scholars), Elsevier (Science Direct), ResearchGate, JSTOR, Biological Abstracts, BioOne, PubMed, Biocompare, SPRESI

**Team** (co-founders and management)

1. Liran Belenzon (Co-founder and CEO)
2. Tom Leung (Co-founder and Chief Scientist)
3. Elvis Wianda (Co-founder and CDO)
4. David Q Chen (Co-founder and CTO/Director of AI)
5. Asaf Inger (VP of Engineering)
6. Rasheed Ahmed (Head of Operations)

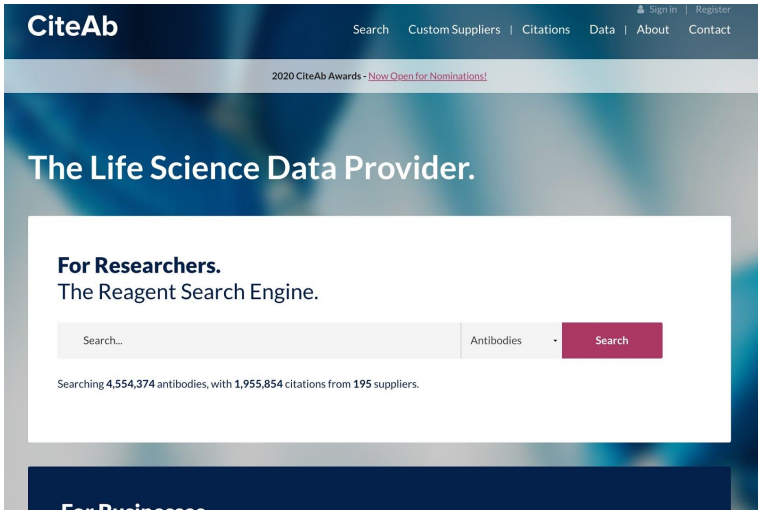
## Competitive Analysis

### Antibody Specific Search Engines

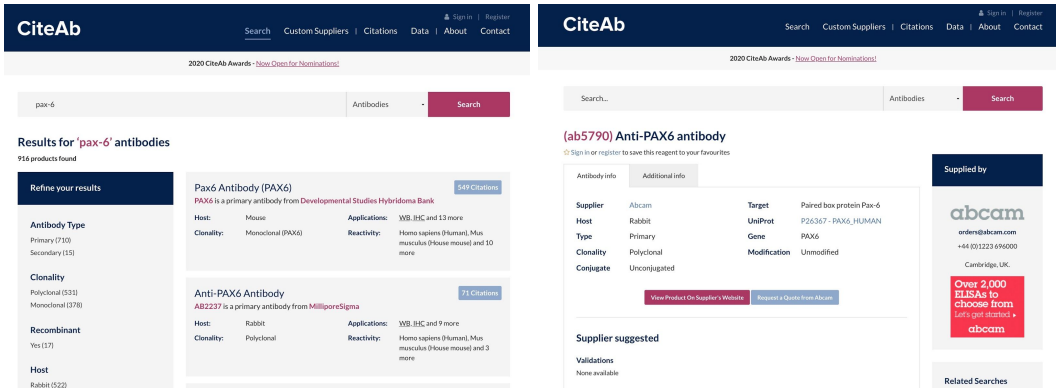
With +300 suppliers worldwide and +3MM antibodies, finding the exact antibody is hard. It is also noted that 50% of research Abs do not work as intended. The current search method to look for specific Ab is to just sift through papers on PubMed and Google Scholar until one finds it. Several "antibody search engines" have been developed to help research scientists more easily identify Ab best suited for their experiments, however most have limitations. Examples of commonly used Ab specific search engines or databases such as CiteAb, Linscott's Directory or even a general catalog such as Biocompare.

### CiteAb

CiteAb started off as an academic project by Dr. Andrew Chalmers from the University of Bath in collaboration with Storm Consultancy in 2012 and was spun out in January 2014 as CiteAb Limited. Its search engine ranks Ab by the number of times they have been cited to help scientists quickly find out the frequency of use in the literature for their antibody of interest. As of July 2019, CiteAB currently[7] has 4,554,374 Ab, with 1,955,854 citations from 195 suppliers.

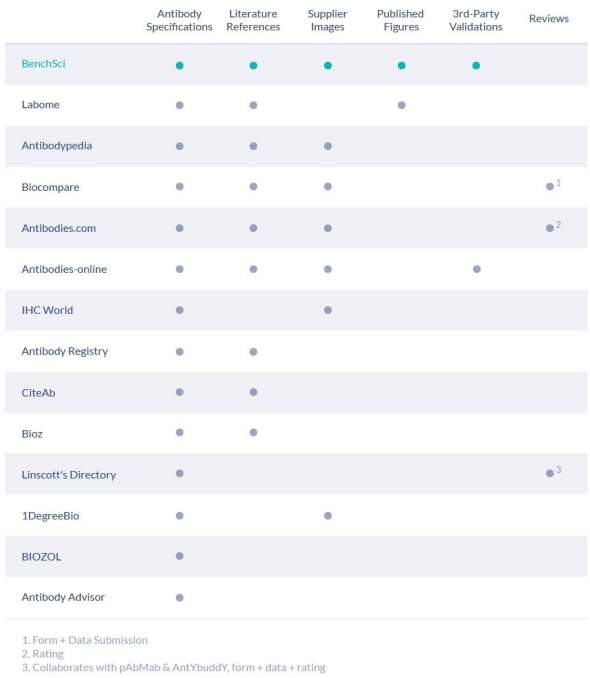



The homepage of CiteAb shows they may want to expand just beyond Ab in the future?




Users can search Ab much like a search engine.

[7] https://www.citeab.com



| | Antibody Specifications | Literature References | Supplier Images | Published Figures | 3rd-Party Validations | Reviews |
|---|---|---|---|---|---|---|
| BenchSci | ● | ● | ● | ● | ● | |
| Labome | ● | ● | | ● | | |
| Antibodypedia | ● | ● | ● | | | |
| Biocompare | ● | ● | ● | | | ● [1] |
| Antibodies.com | ● | ● | ● | | | ● [2] |
| Antibodies-online | ● | ● | ● | | ● | |
| IHC World | ● | | ● | | | |
| Antibody Registry | ● | ● | | | | |
| CiteAb | ● | ● | | | | |
| Bioz | ● | ● | | | | |
| Linscott's Directory | ● | | | | | ● [3] |
| 1DegreeBio | ● | | ● | | | |
| BIOZOL | ● | | | | | |
| Antibody Advisor | ● | | | | | |

1. Form + Data Submission
2. Rating
3. Collaborates with pAbMab & AntYbuddY, form + data + rating

The above table (source: BenchSci[8]) shows some of the limitations of the various Ab search engines available today.

BenchSci prides themselves as the only one (out of its competitors) that provides scientists with the capability of filtering through publication data to find antibodies that have been used under specific experimental conditions. Furthermore BenchSci is working to acquire data from additional closed-access journals (in addition to Springer-Nature, Wiley, Karger, JAMA, FASEB, ASPET , and PNAS) which differentiates them.

**AI Powered Research Tools**

AI powered research tools are particularly important to researchers with the case for BenchSci, finding the right commercial antibody means scanning through endless reams of science literature which equates to more time spent searching.

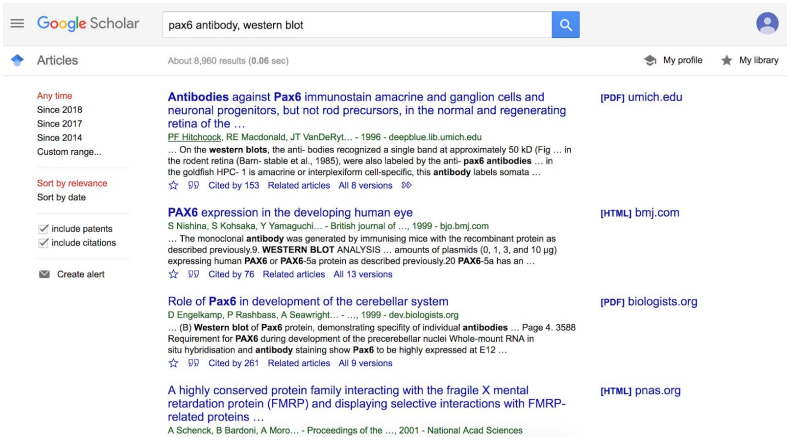
**BenevolentAI[9] (BenevolentBIO)**
BenevolentAI is an AI technology platform (based in London) that ingests and processes knowledge from any source of vast complex scientific data and then analyzes, reasons and extracts knowledge from that particular source. Through BenvolentBIO they apply their AI to improve the efficiency of drug development by allowing researchers to produce better target, optimize compounds from hundreds of millions of sources. The company currently focuses on diseases such as inflammation, neurodegeneration (Parkinson's, Alzheimer's), orphan diseases (ALS) and rare cancers. Though not competing with BenchSci's core product at the moment, it is important to note that because BenevolentAI has other verticals within the life science space, they can easily jump into the same sector that BenchSci is in.

[8] https://blog.benchsci.com/antibody-search-engines
[9] https://techcrunch.com/2018/04/18/benevolentai-which-uses-ai-to-develop-drugs-and-energy-solutions-nabs-115m-at-2b-valuation

## Research & Academic Platforms

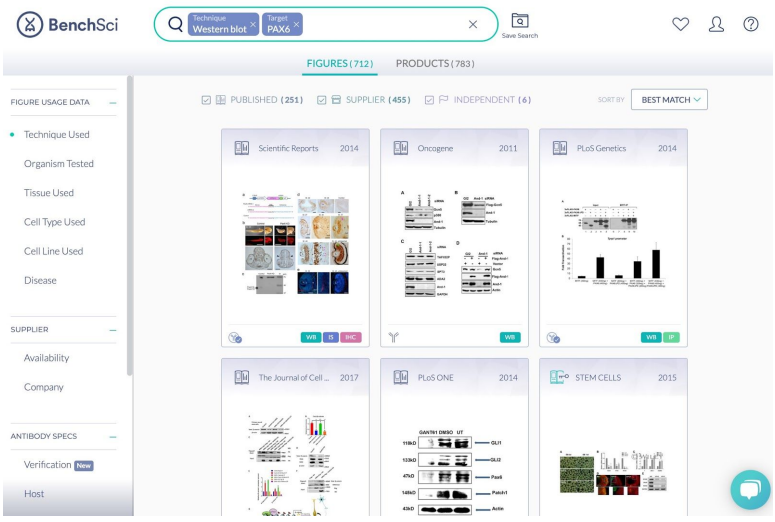
### Google (Google Scholars)

Google Scholar is a free academic search engine that indexes academic information from various online “web” sources. The Google Scholar lists information across an array of academic resources, mostly are peer-reviewed. It works in the same manner as Scirus. Founded in 2004, it is one of the most widely used[10] academic resources for researchers and scholars.




One can see that the search result #2 is already an irrelevant return result to what the search was.

As mentioned by BenchSci[11] - Google Scholar is designed to keep researchers up to date on what’s going on rather than searching for specific Ab. This is demonstrated with searching the Pax6 Antibody where you have some relevant and irrelevant articles. You still have to manually look over the articles to determine if it is relevant to what you are working on.




[10] https://blog.scholasticahq.com/post/why-having-your-journal-indexed-in-google-scholar-matters-more-than-ever-and-steps-to-get-started
[11] https://blog.benchsci.com/antibody-search-on-BenchSci-vs-google-scholar

BenchSci differs by allowing you to specifically search Abs from relevant experiments. Like Google, BenchSci crawls documents to analyze their information where as BenchSci analyzes additional information such as data from Ab vendor/supplier catalogues. Furthermore BenchSci uses various AI/ML methods to understand the meaning of words and phrases, the context of experiments, and the relationship between words and figures. All of these claim that users can find the right antibodies 24x[12] faster than Google Scholar (or PubMed).

The exact method they do this differing from Google Scholar.

1. Aggregate All Relevant Data for More Comprehensive Results
2. Use AI to Decode Full Text and Images for More Relevant Results
3. Apply Aliases to Automatically Expand Searches
4. Build Missing Associations to Unlock Hidden Insights
5. Enable Smart Searching and Filtering to Speed Research
6. Return Figures and Key Data to Reduce Cognitive Overload

## Antibody Manufacturers & Services

An area BenchSci may enter (which makes sense) is antibody manufacturing, since searching the right antibody isn't the only problem, rather procuring an antibody that works. This is due to the fact that many manufacturers of the Ab don't actually use the Ab for research[13]. The key difference with this sector, is with most if not all antibody manufacturers is that one has to actually know what you are looking for prior procurement.

There are two types of antibody manufacturers, the large types tend to have other business units such as mass spectrometry (i.e. Thermo Fisher Scientific) to being a pharmaceutical company (i.e. Merck Group) and small antibody manufacturers focus on making the Ab, reagents, assays and kits (i.e. Cell Signaling Technology).

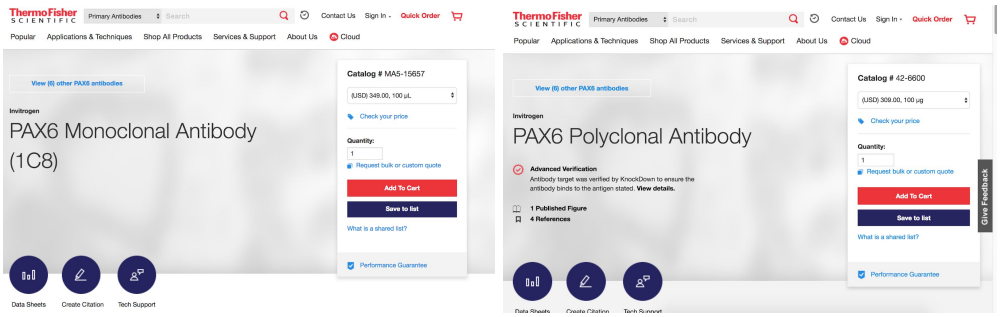

Map of the most commonly used (and cited) Ab manufacturers.

### Thermo Fisher Scientific (Thermo Fisher, Invitrogen)

Thermo Fisher Scientific (TMO) is an American multinational biotechnology product development company, often dubbed as the "arms dealer for pharma and biotech companies"[14]. Created in 2006 through the merger of Thermo Electron and Fisher Scientific, which allowed TMO as one of the leading companies in the genetic testing and precision laboratory equipment markets. Ab are one of the company's most popular

[12] https://landing.benchsci.com/industry
[13] Mentioned by various professors mainly at USC, UCLA, UCI, Caltech during in person interviews
[14] https://www.youtube.com/watch?v=guGDKGkDZ5Q

products. This collection includes primary, secondary, and custom Ab in addition to antibody purification kits and reagents (marketed mainly through the brand Invitrogen).




An example of monoclonal and polyclonal antibody (the example used is pax6)


Some Ab have more detailed information.

Interestingly TMO is the only company that has an Antibody Data Exchange Program[15] designed to collect performance data and research feedbacks on Ab. The program allows researchers to receive free Ab for data - though one has to submit 6 months after purchasing an antibody.

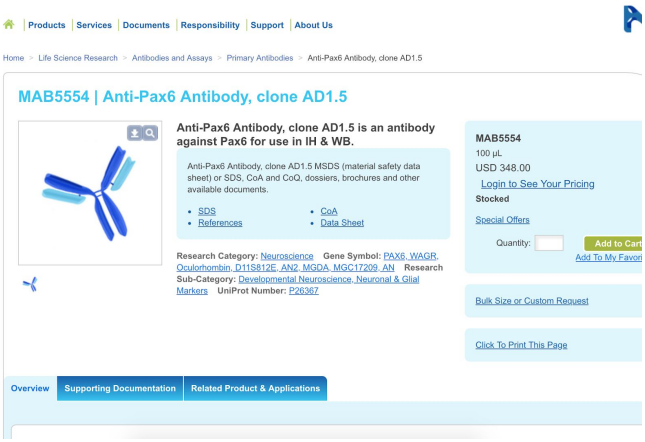
**Merck Group (MilliporeSigma & Sigma Aldrich)**

The Merck Group (not to be confused with US based Merck & Co), branded and commonly known as Merck, is a multinational pharmaceutical, chemical and life sciences company headquartered in Darmstadt, Germany. Merck is known to pioneered the commercialization of morphine in the 19th century and for a time held a monopoly on cocaine. Through Merck, Millipore, is currently the third largest research antibody supplier in the world and prior to Merck's acquisition, Sigma Aldrich was the fifth largest supplier. With both Millipore and Sigma Aldrich, Merck's global market share is 13%.

Sigma-Aldrich (which is now mainly marketed as MilliporeSigma and sometimes Millipore) antibody products include flow cytometry Ab, antigens, IgY Ab, Ab for proximity ligation assays, and antibody kits. The primary Ab for flow cytometry that Sigma-Aldrich develops are mAb (conjugated or purified). Sigma-Aldrich also provides Ab in whole

[15] https://www.thermofisher.com/us/en/home/life-science/antibodies/antibody-data-exchange-program.html

molecule form and as fragments (F(ab)2). In addition to whole antiserum and F(ab)2Ab, Sigma-Alrich produces numerous types other common types of Ab such as fractionated antiserum, IgG fraction of antiserum, affinity isolated antibody (AIA), ascites fluid, tissue culture supernatant, and purified immunoglobulin.

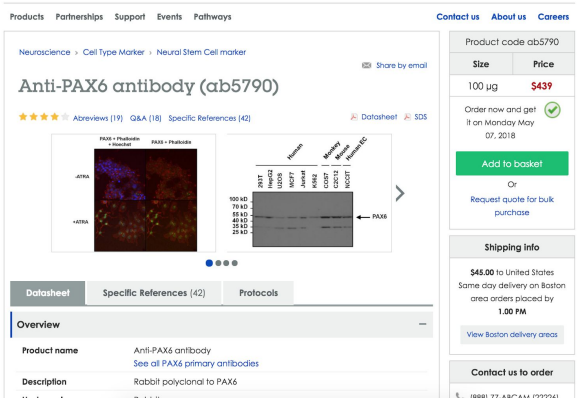


An example of mAb sold on millipore

**Abcam PLC**

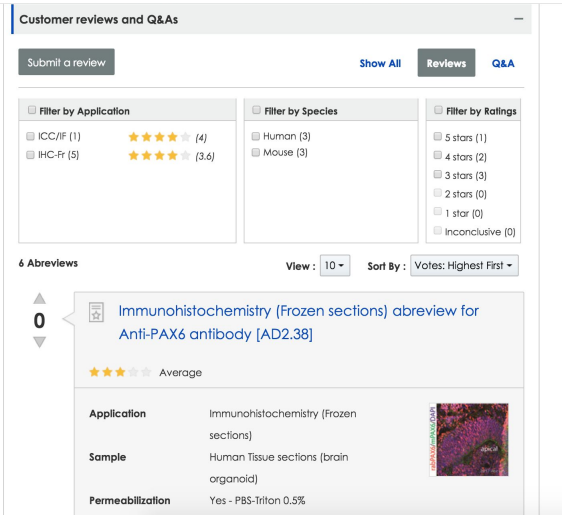
Abcam, is a life-science e-commerce company where it's products are mainly proteins, assays and kits, out of the 3 major providers of Ab[16], Abcam has a focus on antibody research. Unlike Thermo Fisher Scientific and MilliporeSigma, Abcam facilitates public customer feedback on products using reviews and ratings submitted by customers. It's FY 17 revenue was GBP £202M[17] (from GBP £159M in FY 16).

Abcam develops primary Ab that consists of polyclonals, monoclonals, flow cytometry Ab, and conjugated Ab. The polyclonals group of primary Ab include those that detect antigens of immune systems of rabbits, mice, goats, and chickens. Abcam's monoclonals are Ab that are associated with a specific epitope that is within an antigen.



An example of antibody on Abcam (Pax6 antibody - poly)

[16] https://uploads.abcamplc.com/wp-content/uploads/2018/04/03115456/Abcam-plc-2018-JP-Morgan-Conference-Jan-2018.pdf
[17] https://uploads.abcamplc.com/wp-content/uploads/2017/09/22151308/Abcam-plc-Annual-Report-and-Accounts-2017.pdf




An example of reviews on a particular Ab - however not all Ab have reviews or even publication tied to them.

## ECommerce Platforms for Life Sciences

Though an area that BenchSci is not in today, BenchSci can easily go into having a platform that can branch into an ecommerce platform. The B2B eCommerce market is constantly evolving, showing a projected volume of USD $1.1T in the US alone[18] and USD $6.7T[19] globally by 2020.

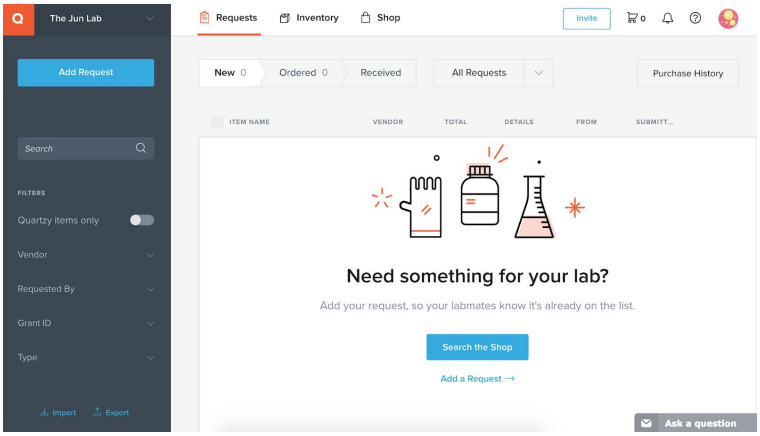
Online marketplaces can provide a substantial added value to its users particularly within life sciences. For example, buyers can quickly compare and select better offerings without the need to research multiple websites and surf online for price comparisons or product specification. Coupled with knowing what proteins (or other reagents to buy), a platform can provide additional value add and ultimately speed up the drug discovery processes.

Although the life sciences industry in general lags behind in adopting e-commerce tools (or any new technology) in the past, it is now showing a growing appetite for new e-business models. However recent examples of AstraZeneca's Innovation Marketplace (AIM), the USD $17B acquisition of leading e-commerce platform Sigma-Aldrich by Merck and life science oriented e-commerce marketplaces such as Quartzy, Scientist.com, and Science Exchange.

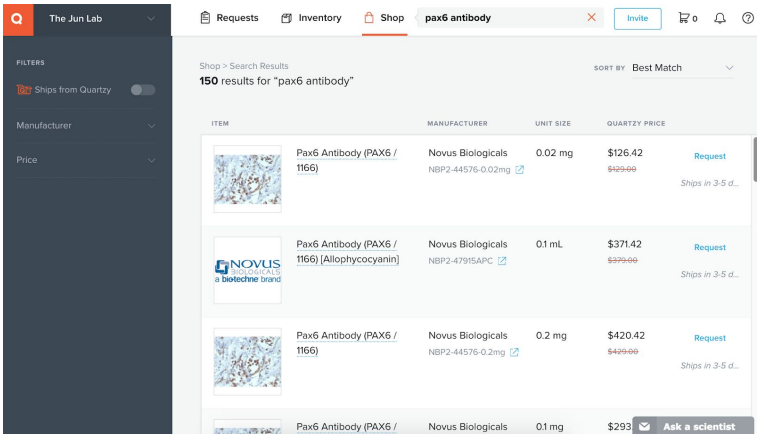
### Quartzy

Quartzy is a hybrid service that combines a lab management software and a marketplace of lab supplies and reagents. Though the company is more focused on buyers (where it can be researchers themselves) who are users of the lab management software which is designed to manage lab inventories, procurement process, budgeting and payments as opposed to a researcher who is acquiring reagents par say. With the software comes a marketplace so that users can search for products from different suppliers hosted within Quartzy catalog.

[18] https://go.forrester.com/blogs/15-04-02-us_b2b_ecommerce_to_reach_11_trillion_by_2020
[19] https://ww2.frost.com/news/press-releases/global-b2b-e-commerce-market-will-reach-67-trillion-usd-2020-finds-frost-sullivan




The homepage of Quartzy which show's it as more of a lab management platform vs. ecommerce platform




Users can search and order directly using the Quartzy platform. Quartzy is basically a modified form of amazon.com but deeper in lab supplies and offering lab management functionality.

This unique hybrid makes an interesting business model, there have been mainly two basic business models in catalog-based e-procurement:

- Buyer Pay Model: Coupa, Sciquest, Tradeshift, Basware, etc. This model charges the buyer a fee and is free to the supplier.
- Buyer and Supplier Pay Model: Evolved to, and followed by, Ariba, etc.

The service is free to use for any buyers, while the suppliers pay a service fee to host on their catalogs.

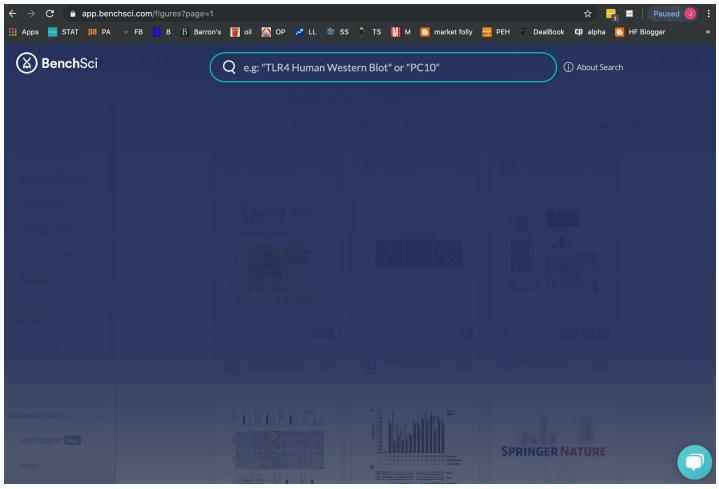
The platform is currently used by +25K other startups, nonprofits, multi-nationals and leading academic labs including: Stanford (Medical School), Oxford, Columbia University, Duke and prominent industrial players[20] such as Gilead, GSK, USDA. The Palo Alto based company was founded in 2009 by Jayant Kulkarni and Adam Regelmann and has raised USD $22.2M to date from investors such as Y Combinator, Khosla Ventures, Jeremy Stoppelman, David Sacks.

[20] https://www.quartzy.com/case-studies/home

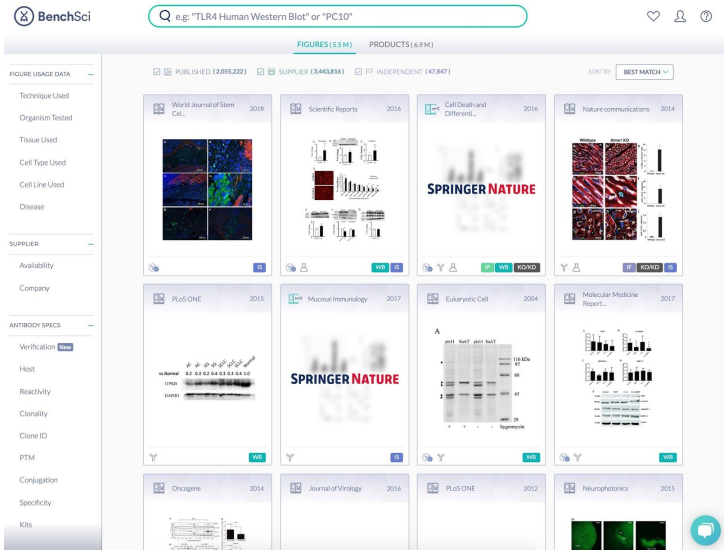
## Product

BenchSci's main product is the AI-Assisted Antibody Selection Platform focusing on antibodies (Ab) and reagents. Used by researchers who use Ab as a tool, the strategy to focus on Ab, makes sense due to them being critical to many widely-used technologies and techniques. Since the commercialization of the first therapeutic monoclonal (mAb) product in 1986, it has grown significantly USD +$98B in sales. Since 2013, the mAbs market has grown between 7.2% and 18.3% YoY and is estimated to reach a global sale of USD +$137-200B[21] by 2022.

Much like a search engine, the user can get started in searching for specific antibodies or use filters (such as Techniques, Manufacturer, Diseases, etc.) to easily identify published figures and the antibody used that match the experimental interest.

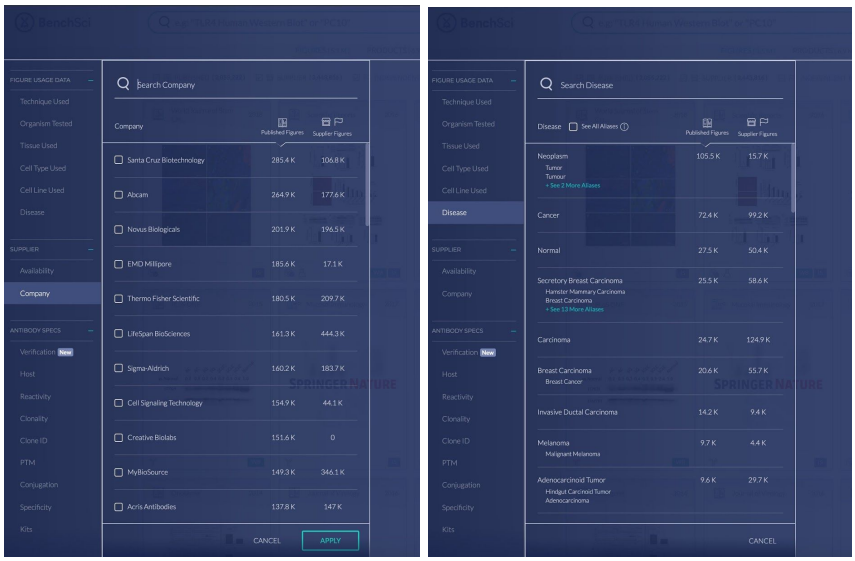



This is what you see when you first log into BenchSci.

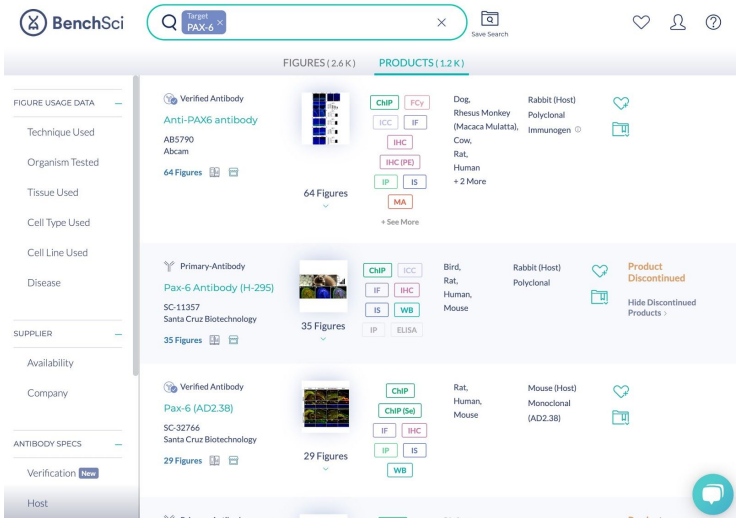



The homepage after clicking into the page (it's a bit cluttered?) but still serves as a search engine.

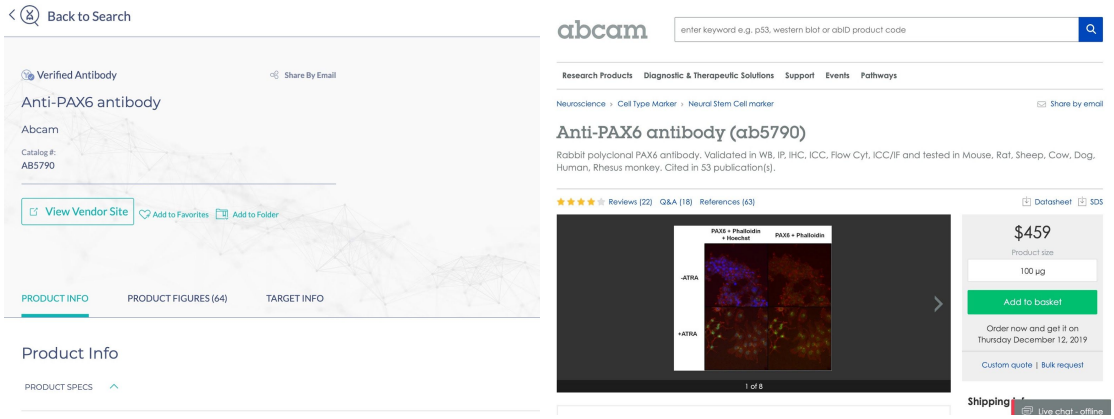
[21] https://www.sciencedirect.com/science/article/pii/S0167779918301495



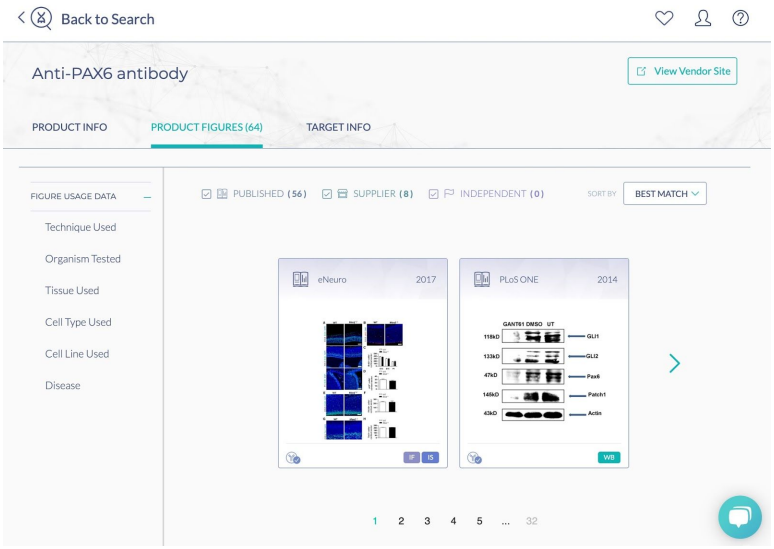

Some of it's key filtered search features is that users can also search by manufacturers and diseases.



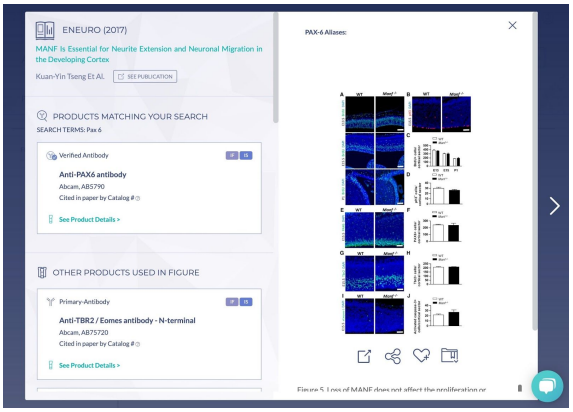

Once you search for a specific Ab, the search results list much like a search engine does.




After selecting the specific Ab, the user can directly access the vendor of the Ab.




If the user scrolls to the bottom then, one can find published papers associated with the Ab.

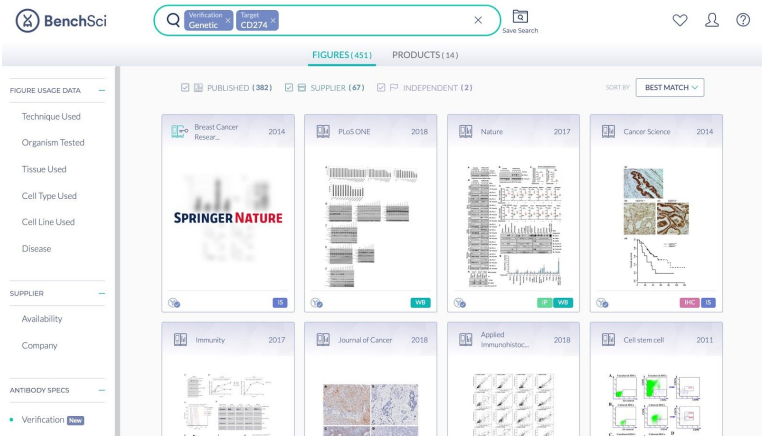




And lastly it links to every published paper using that particular Ab as shown with 1/56 available published papers

The latest feature is the verified antibodies filter feature which was announced on October 17 2019[22], which allows users the ability to identify antibodies on BenchSci that have been verified by knockout/knockdown (KO/KD) or overexpression (OE) experiments in the literature. The (KO/KD) is currently the most commonly adopted antibody validation method among the 5 pillars proposed by Uhlen et al. 2016[23], as well as antibodies that have been verified by overexpression experiments. BenchSci started by training their machine learning algorithms to decode scientific publications. BenchSci focused on where they believe could make the biggest impact: detecting antibody usage in the literature to combat the "Antibody Crisis,".

[22] https://blog.benchsci.com/benchsci-now-decoding-additional-reagents-used-in-experiments-to-help-you-find-verified-antibodies
[23] https://www.ncbi.nlm.nih.gov/pubmed/27595404




The verified feature will pave the way for BenchSci to be able to help scientists “find” the right biological reagents for any experiments, based on their usage throughout the literature.

**Why AntiBodies?**

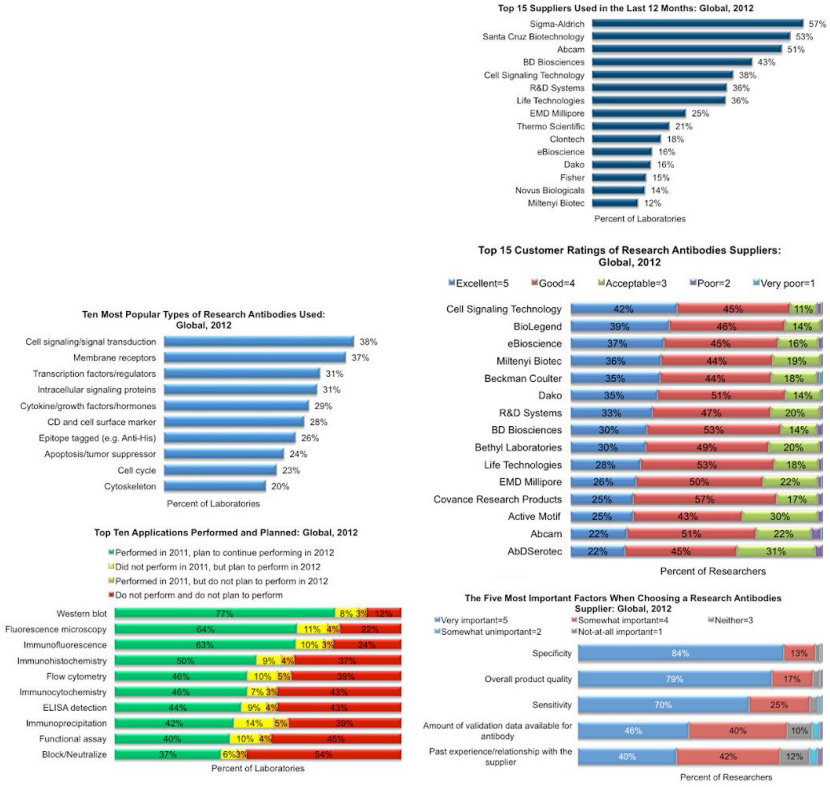
BenchSci helps researchers find the right antibody which is often described as “finding a needle in a large haystack, that is there”. This is due to the fact that there are +300 antibody suppliers selling millions of Ab, which makes the procurement process a daunting process since research outcome highly dependent on the experimental contexts in which the antibody was used. Using machine learning to scan millions of data points in research papers, BenchSci is able to generate searchable results. It is important to note, there are over +10 billion[24] synthesized Ab today (not including “future” customizable Ab) that either:

- Monocolonal (mAb or moAb) represents antibody from a single antibody producing B cell and therefore only binds with one unique epitope. The are high specificity/low sensitivity.
- Polycolonal (pAb) represents a collection of Ab from different B cells that recognize multiple epitopes on the same antigen. Each of these individual Ab recognizes a unique epitope that is located on that antigen. They are low specificity/high sensitivity.

Another thing to note is that Ab are made in batches[25] and sorted by lot numbers where each batch is different almost in the way that not “every meal” is the same.

[24] Introduction to Protein Science: Architecture, Function, and Genomics by Arthur Lesk (2016)
[25] https://www.ncbi.nlm.nih.gov/books/NBK100189


Comparison of number of antibodies in databases from BenchSci[26] (note some figures are estimates).




The wide applications, usage and suppliers/manufacturers of Ab based on a survey done in 2012 by The Scientist[27]

[26] https://blog.BenchSci.com/antibody-search-engines
[27] https://www.the-scientist.com/?articles.view/articleNo/32042/title/Antibodies-User-Survey

The process for procuring an antibody follows (based on interviews[28] done at USC, UCLA, UC Irvine, Caltech, Stanford, Berkeley and Columbia University) shows what researchers take into consideration:

1. Reputation
    a. the most common method that researchers start is word of mouth and "taking the word of other researchers"
    b. popular suppliers (often times high price/high quality - if it works): Abcam, Thermo Fisher, Invitrogen, MilliporeAldrich, Sigma Aldrich
    c. lesser known (lower quality but low cost): Cell Signaling Technology, Santa Cruz Biotechnology
    d. Past experiments where Ab from that manufactures have worked
2. Do manufacturers of Ab show evidence/results?
    a. specificity and/or sensitivity (i.e. "Our antibody detects antigens at X% in X amount of solution")
    b. how and why?
3. Price
    a. Ab are very expensive for small quantities
    b. custom Ab are even more expensive and typically costs USD $2K-10K on average
        i. mAbs cost more and an example is Campath (Alemtuzumab) which is used to treat chronic lymphocytic leukemia (CLL), cost about USD $20K [29] a dose and roughly USD $60K/yr
        ii. this matters more for research universities since funding for research is very competitive where only 7-9% get funding from NIH and NSF
4. Quality & Purity
    a. recent studies points that an unexpected high number papers seem to be not be reproducible[30] [31]. Amgen and Bayer HealthCare, were not able to reproduce most of the examined landmark papers in their field.

The idea with BenchSci users can go through steps 1-4 with ease.

Furthermore BenchSci can ultimately provide opportunities long term is not with existing antibodies where it tells you how to choose and what to use, but eventually tell you what sort of antibody "one should develop" for a particular outcome based on the protein one is looking at.

**Market, Industry & Trends**

BenchSci touches several verticals in the life sciences sector[32] in both the biotech and pharma, as the clinical laboratory services markets. It's initial core product targets the immunology and the Ab, as well as proteomics market.

**Biotech and Pharma**

[28] Interviews were done via directly talking to professors, graduate students - the sample size totalling 40 individuals
[29] https://multiplesclerosis.net/living-with-ms/lemtrada-economics-ms-treatments
[30] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4803150
[31] This is something that was mentioned by almost all the researchers during the interview period more than once
[32] https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Life-Sciences-Health-Care/gx-lshc-ls-outlook-2018.pdf

The global pharma market is expected to reach USD $1.12T[33] by 2022 with a CAGR of 6.3% with PhRMA (Pharmaceutical Research and Manufacturers of America) estimating US companies will invest USD +$75B[34] annually in R&D. The global biotech market is expected to reach USD $727.1B by 2025 with a CAGR of 7.4%

- The global drug discovery technology market is estimated to reach USD +$85.8B[35] by 2022 with a CAGR of 9.4% from 2017-2022.

The monoclonal Ab (mAbs) was worth USD $100B[36] and the global Ab research market was $2.4B[37] in 2017. It was estimated that the mAbs market will be worth $125B[38]

- The high growth of mAbs market is due to "the pharmaceutical industry having a pressing need for new therapies with novel mechanisms of action..." "this has benefited the monoclonal antibody market, with areas of industry concern such as drug resistance are helping to drive development." as mentioned by Bruce Carlson (Publisher at Kalorama Information).
- The limited efficacy of conventional therapies combined with serious side effects has contributed to the increased demands for mAbs.
- The molecular biology enzymes and kits & reagents market is projected to be worth $26.7B[39] by 2025 with a CAGR of 15.8%[40].
- According to Abcam[41] the global life science research tools market is estimated to be $2.7B, of which the primary antibody research sector is estimated at $906M.

The global proteomics market is estimated to reach USD $21.87B[42] by 2021 growing at a CAGR of 11.7% between 2016-2021.

- The protein expression market was worth USD $1.4B in 2016 and expected to grow +$3B [43] by 2023.

The clinical laboratory services market worth USD $146.41B by 2022 and $327B[44] by 2025, $113.44B in 2017 with a CAGR of 5.2%.

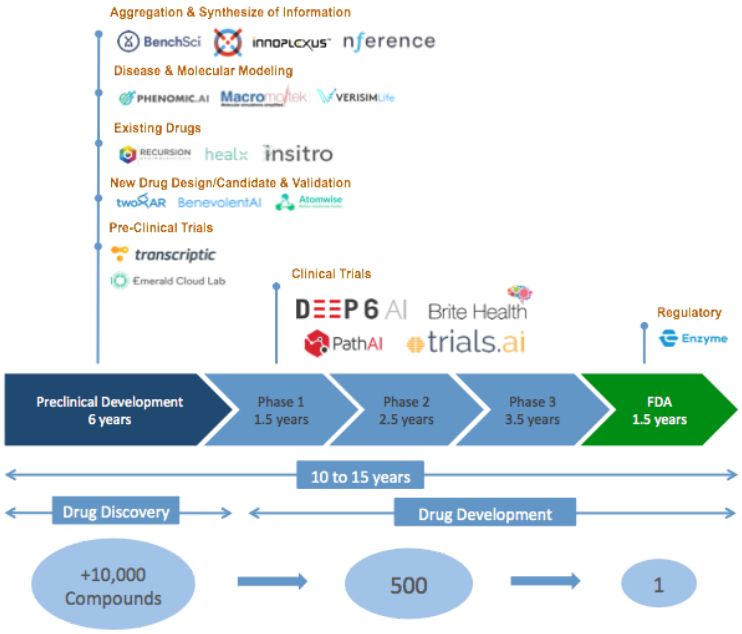
While AI has long held promise for drug discovery with hundreds of startups around the world applying the technology in this area, practical use cases and real-world impact are still harder to find but is quickly becoming a growing interest in the industry. The application of machine learning and natural language processing (NLP) techniques can lead to improved predictive modeling and simulation capabilities through the integration of real-world data and electronic medical records from disparate sources. When integrated, this data could mean improved candidate screening and trial selection, optimization of clinical trial designs and better prediction of drug demand. BenchSci's technology, provides focuses on the failure of scientific experiments that can delay drug discovery projects (by weeks to months) due to the selection of inappropriate reagents.

[33] http://pharmaceuticalcommerce.com/business-and-finance/global-pharma-market-will-reach-1-12-trillion-2022
[34] http://phrma.org/industryprofile
[35] https://globenewswire.com/news-release/2018/02/13/1340167/0/en/Drug-Discovery-Technology-Market-to-Reach-85-8B-in-2022.html
[36] https://www.prnewswire.com/news-releases/global-monoclonal-Ab-market-hit-100-billion-in-2017-report-300599684.html
[37] https://www.prnewswire.com/news-releases/the-global-market-for-research-Ab-is-expected-to-grow-to-30-billion-by-2022-from-24-billion-in-2017-at-a-compound-annual-growth-rate-cagr-of-48-from-2017-to-2022-300582727.html
[38] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4622599
[39] https://www.grandviewresearch.com/press-release/global-molecular-biology-enzymes-kits-reagents-market
[40] https://www.marketsandmarkets.com/Market-Reports/molecular-biology-enzymes-kits-reagents-market-164131709.html
[41] https://uploads.abcamplc.com/wp-content/uploads/2017/09/22151308/Abcam-plc-Annual-Report-and-Accounts-2017.pdf
[42] https://www.marketsandmarkets.com/PressReleases/proteomics.asp
[43] https://www.businesswire.com/news/home/20171213005813/en/Global-3-Billion-Protein-Expression-Market-Analysis
[44] https://www.grandviewresearch.com/press-release/global-clinical-laboratory-services-market

Drug discovery programs in general are very long, expensive and have a high number of failure where they involve:

1. detecting potential drug targets with Ab
2. finding candidate molecules with a therapeutic effect on the disease state, and
3. confirming effectiveness through preclinical/clinical trials before being approved

The entire process can take 12 years[45] (where 1 & 2 described can take up to 6 years) with each NDA (New Drug Applicant) roughly costs USD +$2.6B[46]. More specifically it takes mAb derived drugs from Investigational New Drug Application (IND) to approval 7.6 years[47] with mAb developers achieving a relatively high rate of success vs. any other compounds. There are several examples of AI startups tackling various stages of the drug discovery sectors are BenevolentAI, Recursion Pharmaceuticals and the most recent insitro.




A brief overview of the innovations within the AI space of drug discovery & development market.

The first bottleneck (in productivity) is the massive amount of data output that still needs to be interpreted. During the early stages of drug discovery (target ID) when medical researchers struggle to validate pharmacological targets because they must spend hours reading through the scientific literature to find appropriate Ab for pharmacological targets. Moreover, if inappropriate Ab are used, false negatives and failed experiments can translate to a significant waste of time and money. In fact, the inappropriate use of Ab is one of the leading causes of the reproducibility crisis[48] [49] [50]. According to BenchSci, researchers can find reliable Ab roughly 24x faster[51] and 75% cheaper than current methods due to their AL methods.

[45] https://www.pharmaceutical-journal.com/publications/tomorrows-pharmacist/drug-development-the-journey-of-a-medicine-from-lab-to-shelf/20068196.article
[46] https://www.forbes.com/sites/matthewherper/2017/10/16/the-cost-of-developing-drugs-is-insane-a-paper-that-argued-otherwise-was-insanely-bad
[47] https://www.fiercebiotech.com/biotech/blockbuster-antibodies-face-a-unique-set-of-challenges
[48] https://www.researchgate.net/publication/304046209_IS_THERE_A_REPRODUCIBILITY_CRISIS
[49] https://www.ncbi.nlm.nih.gov/pubmed/27225100
[50] https://sciencebasedmedicine.org/is-there-a-reproducibility-crisis-in-biomedical-science-no-but-there-is-a-reproducibility-problem
[51] https://www.pehub.com/2018/05/inovia-capital-leads-8-mln-series-funding-BenchSci

**Team**

Founded in Toronto in 2015 by Tom Leung (CSO), Elvis Wianda (CDO) and David Chen (CTO) with Liran Belenzon (CEO) joining as the last co-founder in 2016 . The exact idea came from Tom when he was facing the problem during his time as a PhD student in Epigenetics leading to the creation of BenchSci. BenchSci calls themselves the “platform for biomedical researchers —for all of the scientists who are trying to find cures for and prevent diseases”.

**Liran Belenzon**[52] (Co-founder and CEO) prior to founding BenchSci was an MBA candidate where he spent time as a summer associate at the Chinook Capital Group. Liran also co-founded Biz-Coupon (which was dubbed as Israel's first B2B ecommerce website) and also co-founded another business in the advertising space. Liran also served in the Israeli Defense Force (IDF) as a commander within the Office for Soldier Welfare and Recruiting Operations. Liran obtained a bachelor's (business management/law) at the IDC Herzliya and an MBA from the University of Toronto.

**Tom Leung**[53] [54] (Co-founder and Chief Scientist) prior to founding BenchSci has mainly been in academic at the University of Toronto where he was a research assistant in virology and a postdoctoral fellow in epigenetics. Tom also obtained a bachelor's (human biology), masters (virology) and PhD (epigenetics) from the University of Toronto. Tom for his PhD investigated the molecular mechanism of repressive genetic bookmarking during cellular division and the potential application of reversing these bookmarks as alternative cancer therapeutic approaches.

**Elvis Wianda** (Co-founder and Chief Data Officer) prior to BenchSci also has been in academics where he focused on the functional connectivity measurement methods for neuroimaging with non-invasive Magnetoencephalography MEG. Elvis obtained a bachelor's (biochemistry) at University Buea, masters (biomedical engineering) from University of Applied Science Aachen, second masters (electrical/computer engineering) from McMaster University and PhD (health/medical physics) at the University of Toronto.

**David Chen** (Co-founder and CTO/Director of AI) is considered to be the first co-founder recruited by Tom. Prior to BenchSci was PhD candidate where he studied the trigeminal neuralgia through population diffusion magnetic resonance imaging and tractography with machine learning. David was also a research assistant at the University Health Network (Toronto Western Hospital) where he performed analysis of brain DTI imaging along with modeling tumors to diffusivity analysis. David obtained a bachelor's (computer science) and a PhD (neuroscience) all at the University of Toronto.

[52] https://www.creativedestructionlab.com/2018/05/liran-belenzon-from-mba-to-startup-ceo-and-cofounder
[53] https://ecrlife420999811.wordpress.com/2018/05/17/interview-with-scientist-dr-tom-leung
[54] http://clamps.sa.utoronto.ca/files/2017/09/January-2017-Issue.pdf