




AI

FOR DRUG DISCOVERY, BIOMARKER DEVELOPMENT AND ADVANCED R&D LANDSCAPE OVERVIEW Q2 2021

AI Companies - 300
Investors - 880+
Corporations - 100

DEEP PHARMA INTELLIGENCE

www.deep-pharma.tech

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Introduction

This 190-page "**AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview Q2 2021**" report marks the ninth installment in a series of reports on the topic of the Artificial Intelligence (AI) application in pharmaceutical research industry that DKA Pharma Division have been producing since 2017.

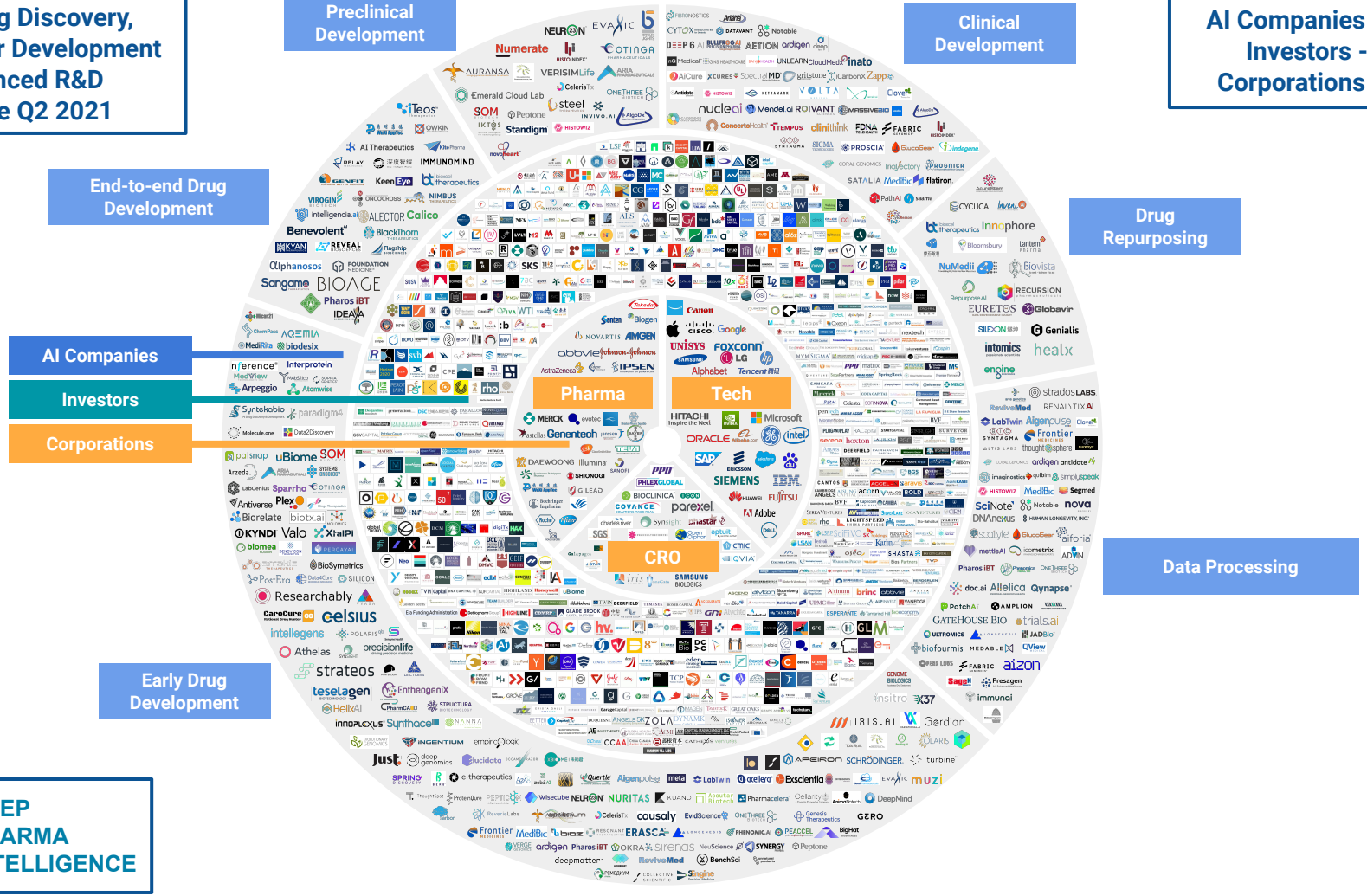
The main aim of this series of reports is to provide a comprehensive overview of the industry landscape in what pertains adoption of AI in drug discovery, clinical research and other aspects of pharmaceutical R&D. This overview highlights trends and insights in a form of informative mind maps and infographics as well as benchmarks the performance of key players that form the space and relations within the industry. This is an overview analysis to help the reader understand what is happening in the industry nowadays and possibly give an idea of what is coming next.

Substantial updates have been introduced since the previous edition, which highlights fast-pacing industry dynamics, and overall growth of investment and business development activity in the area of pharmaceutical AI. The lists of AI-biotech companies, biotech investors, and pharma organizations have been expanded to include new entities, and a new list of leading contract research organizations (CROs) has been added to outline the growing interest of contract research industry in the advanced data analytics technologies. We have also revisited data and chapters from the last edition, and reflected on the changes that occured ever since.

Alongside investment and business trends, the report also provides technical insights into some of the latest achievements in the AI application and research.

AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Q2 2021

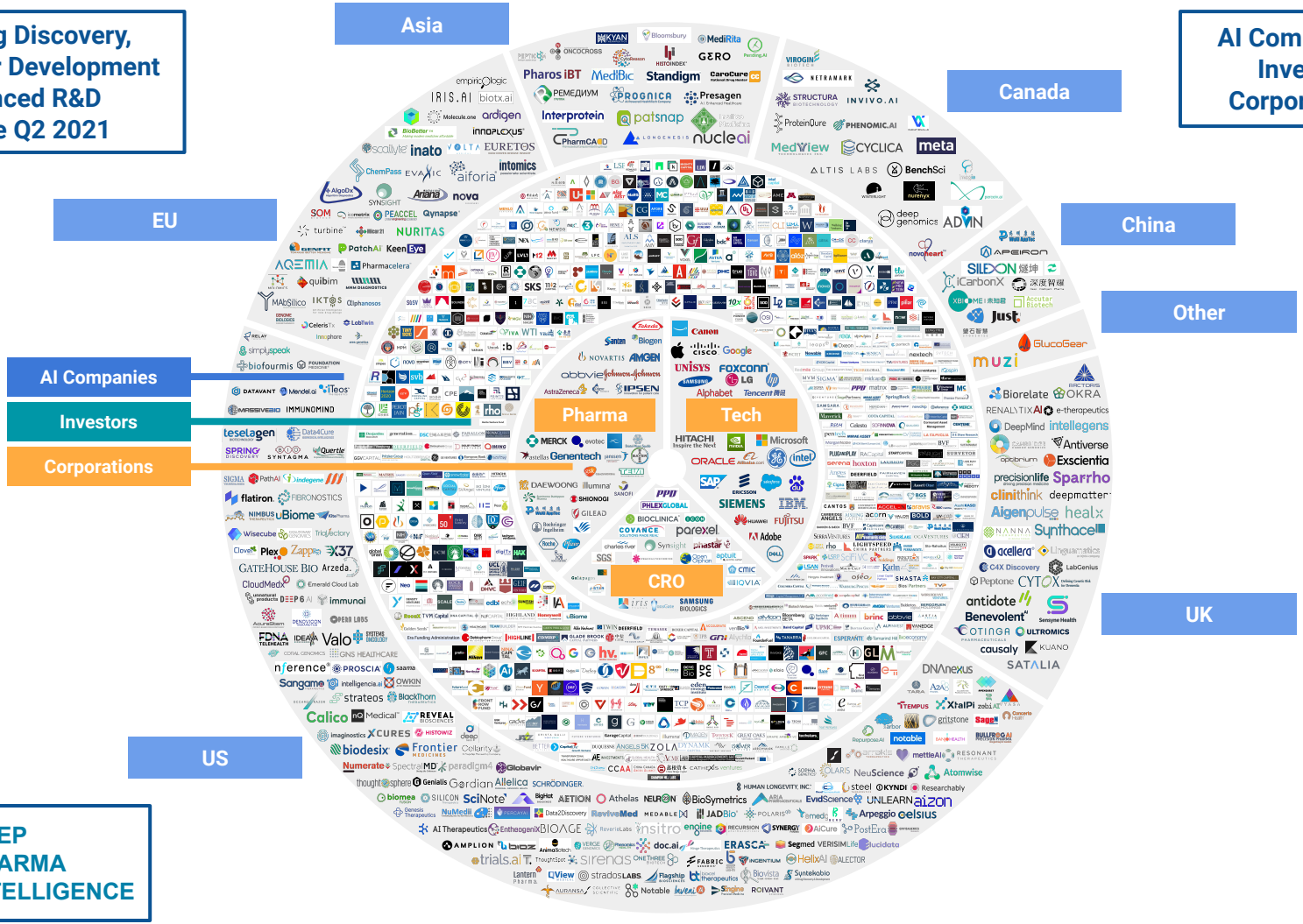
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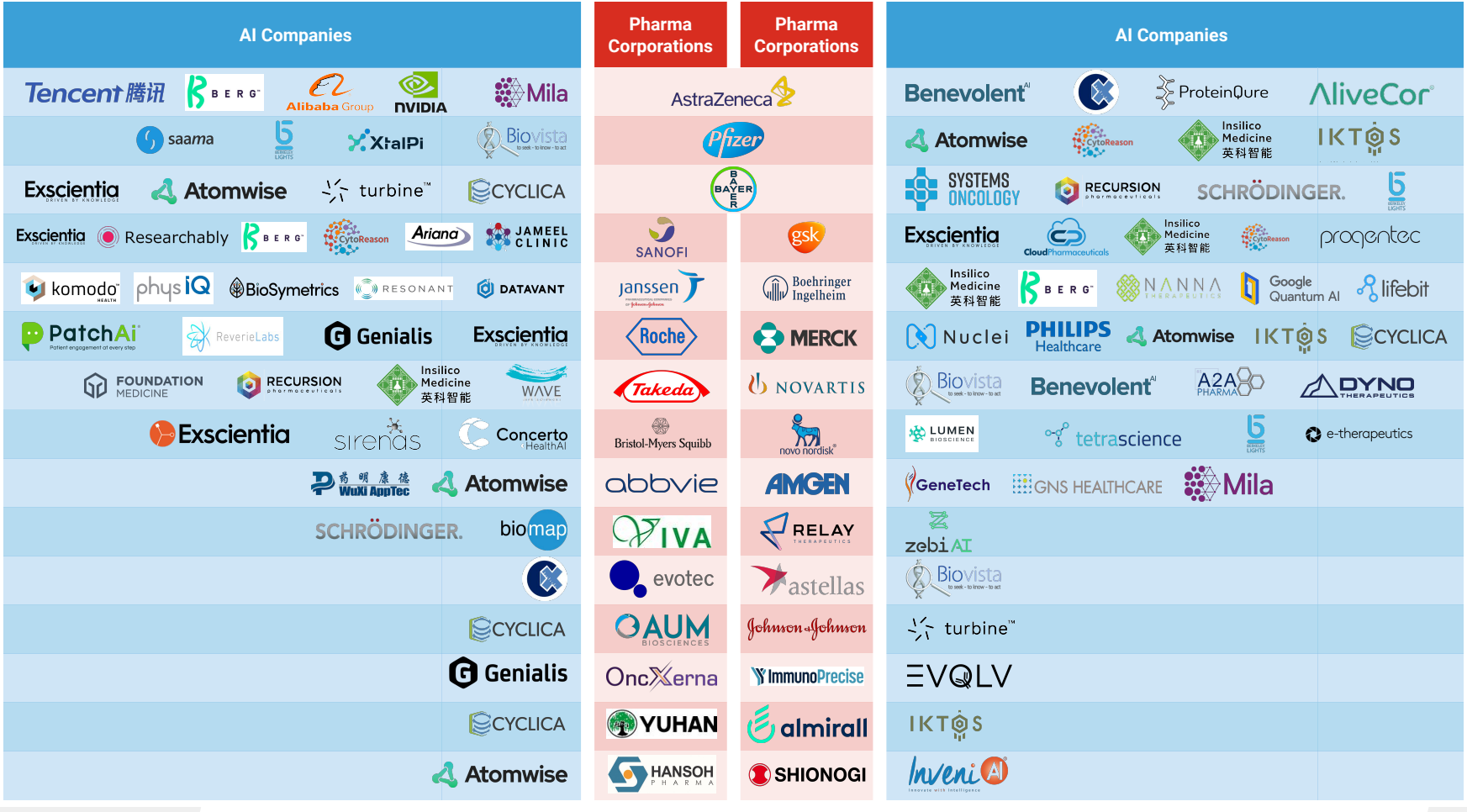
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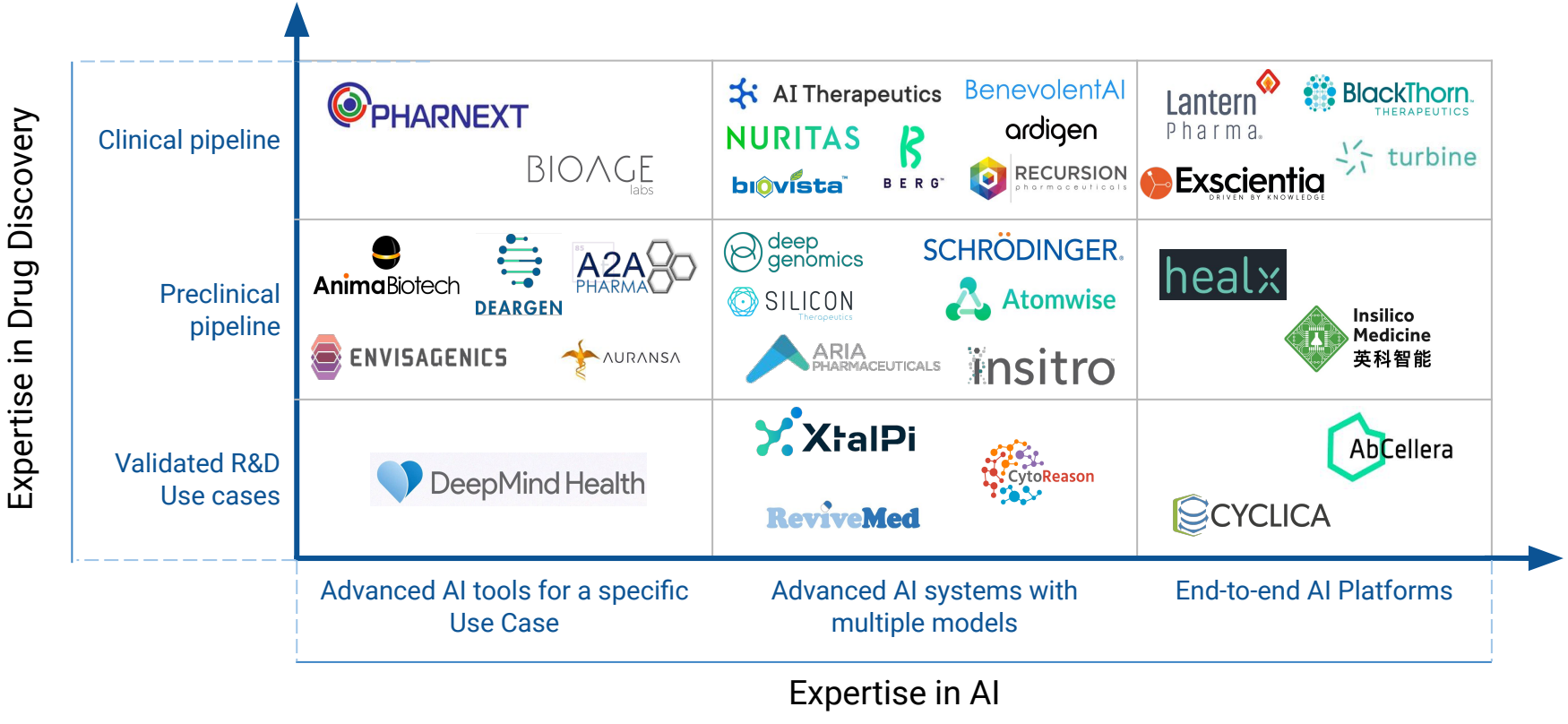


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Selected Pharma AI Deals Structure until 2021



Comparison of Top-33 Leading AI for Drug Discovery Companies Expertise in Drug Discovery R&D



30 Leading Companies in AI for Drug Discovery Sector

1	Aetion
2	Alector
3	Atomwise
4	Benevolent.AI
5	Berkeley Lights
6	Biodesix
7	Cellarity
8	Erasca
9	Exscientia
10	Flatiron Health
11	Gritstone Oncology
12	Human Longevity
13	iCarbonX
14	Indegene
15	Insilico Medicine
16	Insitro
17	ITeos Therapeutics
18	Nimbus Therapeutics
19	PathAI
20	PatSnap
21	Recursion Pharmaceuticals
22	Relay Therapeutics
23	Roivant Sciences
24	Schrödinger
25	SOPHiA GENETICS
26	Synergy Pharmaceuticals
27	Tempus
28	ThoughtSpot
29	Valo Health
30	XtalPi

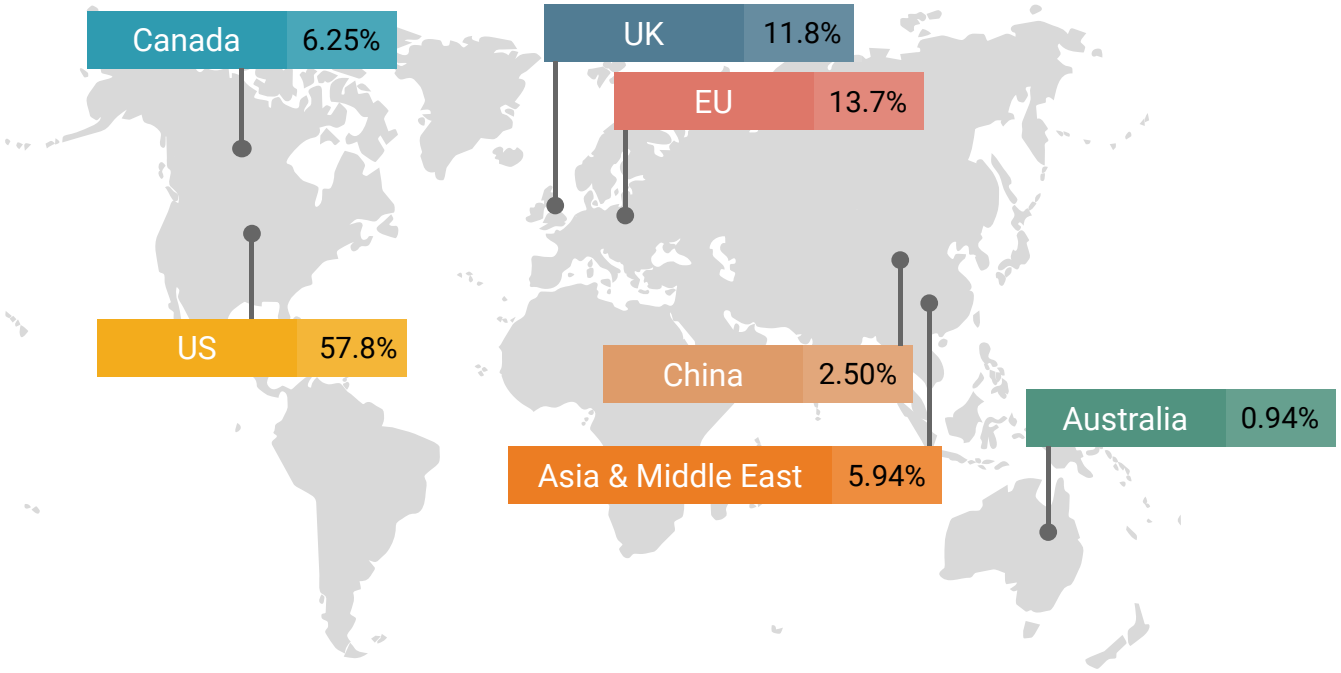
50 Leading Investors in AI for Drug Discovery Sector

1	GV
2	Casdin Capital
3	DCVC
4	Y Combinator
5	Lux Capital
6	WuXi AppTec
7	Andreessen Horowitz
8	EASME - EU Executive Agency for SMEs
9	Lilly Asia Ventures
10	OS Fund
11	AME Cloud Ventures
12	ARCH Venture Partners
13	Felicis Ventures
14	Alexandria Venture Investments
15	Tencent
16	Third Rock Ventures
17	ZhenFund
18	Amadeus Capital Partners
19	Bill & Melinda Gates Foundation
20	Celgene
21	EDBI
22	F-Prime Capital
23	Foresite Capital
24	Founders Fund
25	Inovia Capital

50 Leading Investors in AI for Drug Discovery Sector

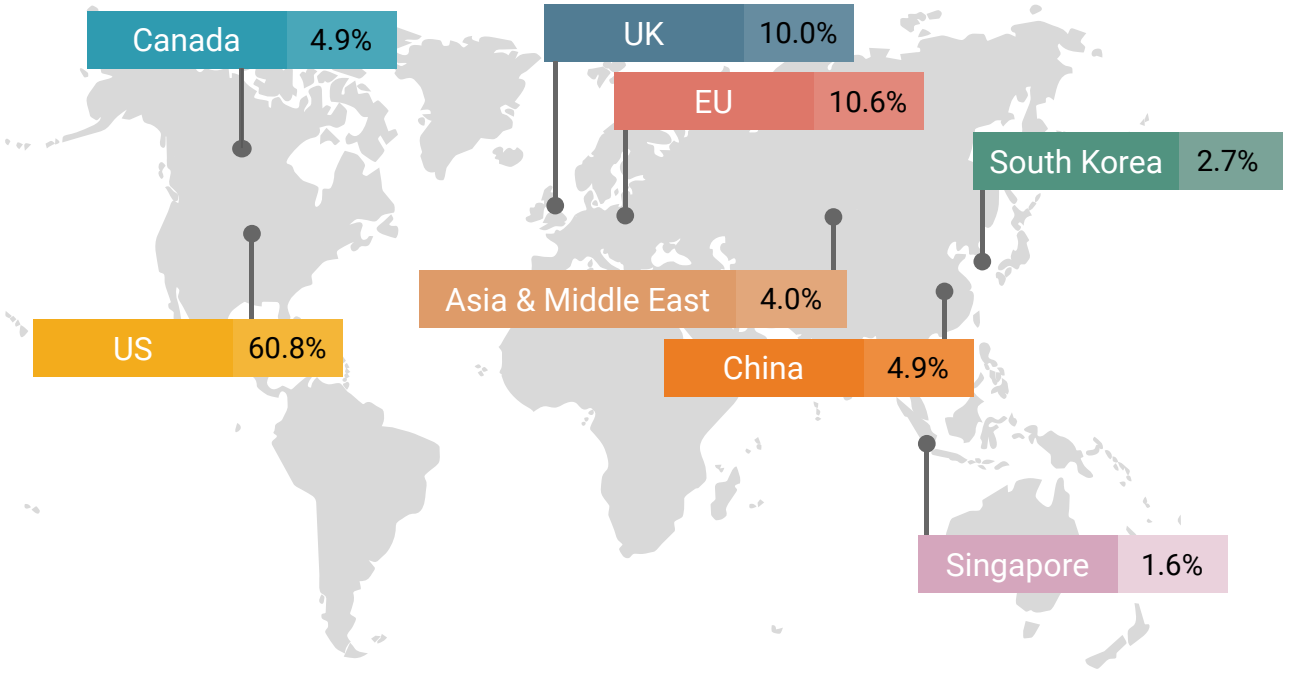
26	New Enterprise Associates
27	Khosla Ventures
28	Perceptive Advisors
29	SoftBank Vision Fund
30	Sequoia Capital China
31	8VC
32	T. Rowe Price
33	6 Dimensions Capital
34	Amgen Ventures
35	Baidu Ventures
36	Baillie Gifford
37	General Catalyst
38	B Capital Group
39	Bristol-Myers Squibb
40	DCVC Bio
41	EPIC Ventures
42	GT Healthcare Capital Partners
43	Obvious Ventures
44	Lifeforce Capital
45	Novo Holdings
46	Octopus Ventures
47	OrbiMed
48	SOSV
49	Revolution
50	Two Sigma Ventures

300 AI Companies: Regional Proportion



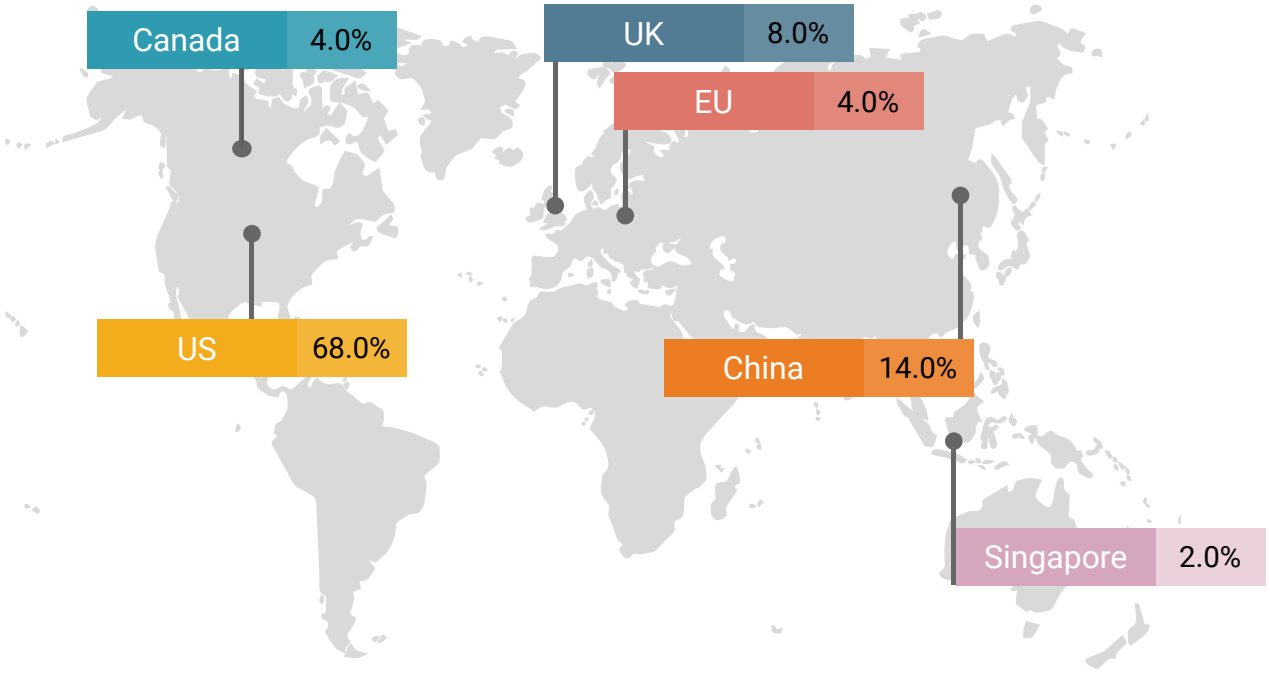
The US is still firmly in the lead in terms of its proportion of AI for Drug Discovery companies. Interestingly, Asia currently has the fourth-lowest proportion of AI for Drug Discovery companies. However, Asia-Pacific region has begun to aggressively increase its activity in the space in terms of investments into foreign companies (largely US-based companies), and we expect to see an increase in the number of AI for Drug Discovery Companies located in the Asia-Pacific region generally, and in China particularly.

880+ Investors: Regional Proportion



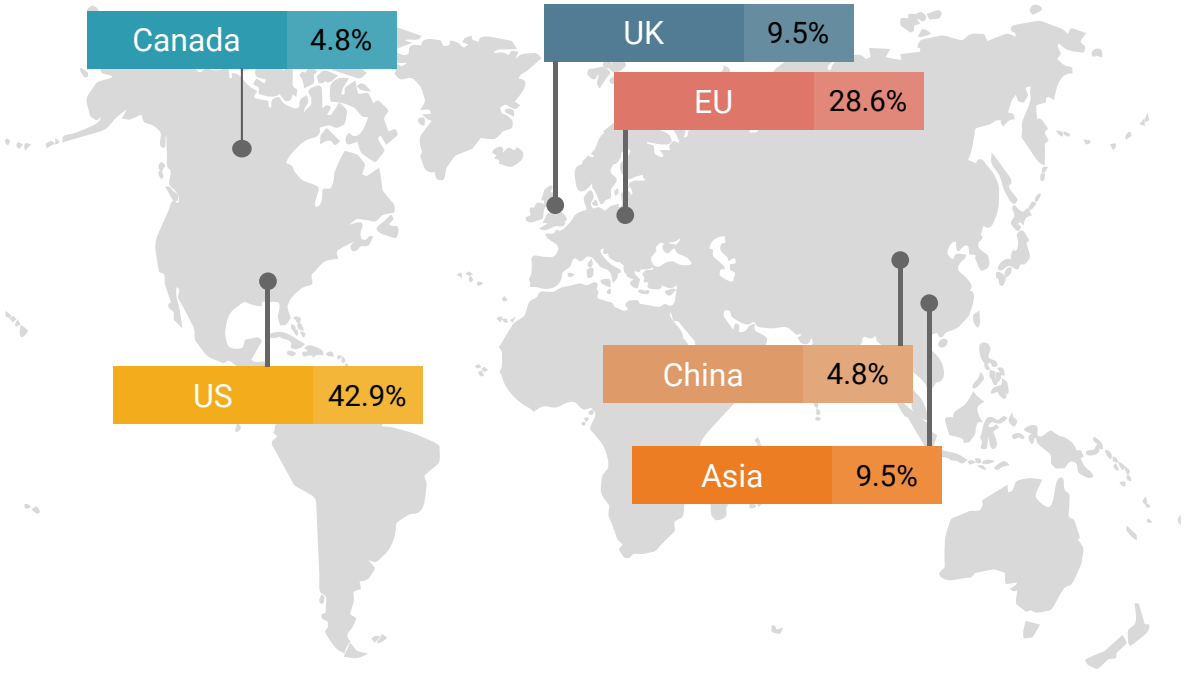
The United States continues to lead the rest of the world in terms of artificial intelligence for companies and funds that invest in Drug Discovery. This is reasonable, given that more than a half of the world's AI for Drug Discovery companies have their headquarters in USA. Comparing with previous periods of 2020, we can observe significant growth of the number of investors in the USA and EU. Thus, together with UK these regions are leaders by the number of investors in AI in Drug Discovery companies.

50 Leading Investors: Regional Proportion



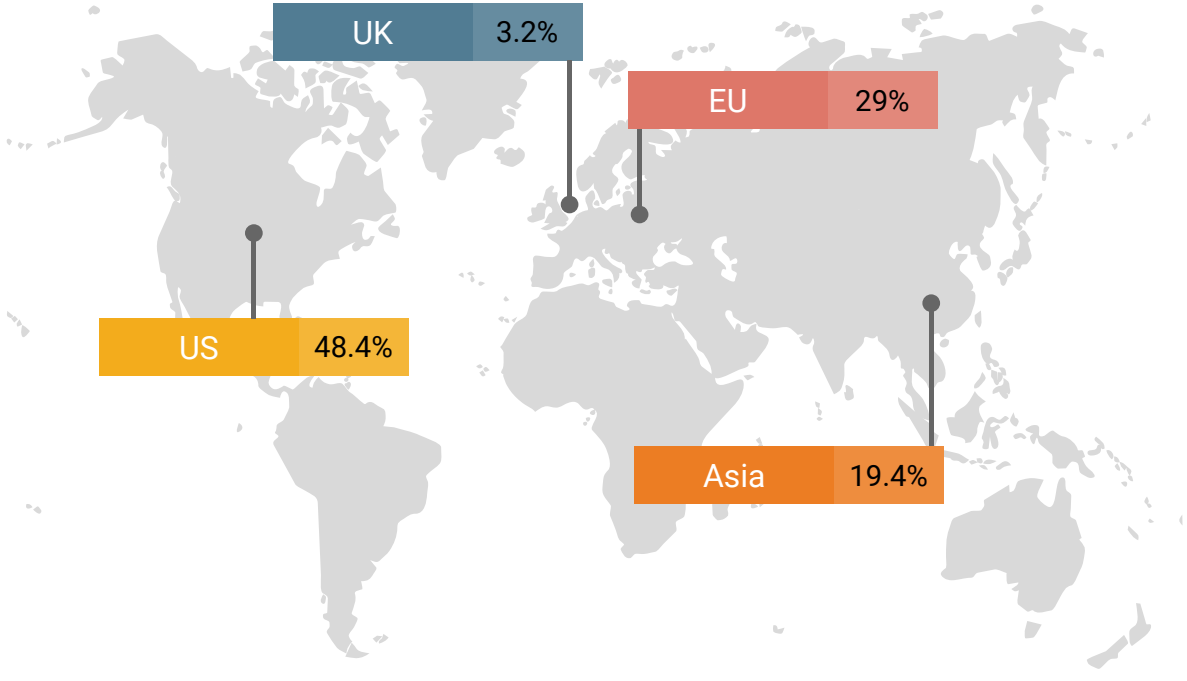
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21 CROs: Regional Proportion



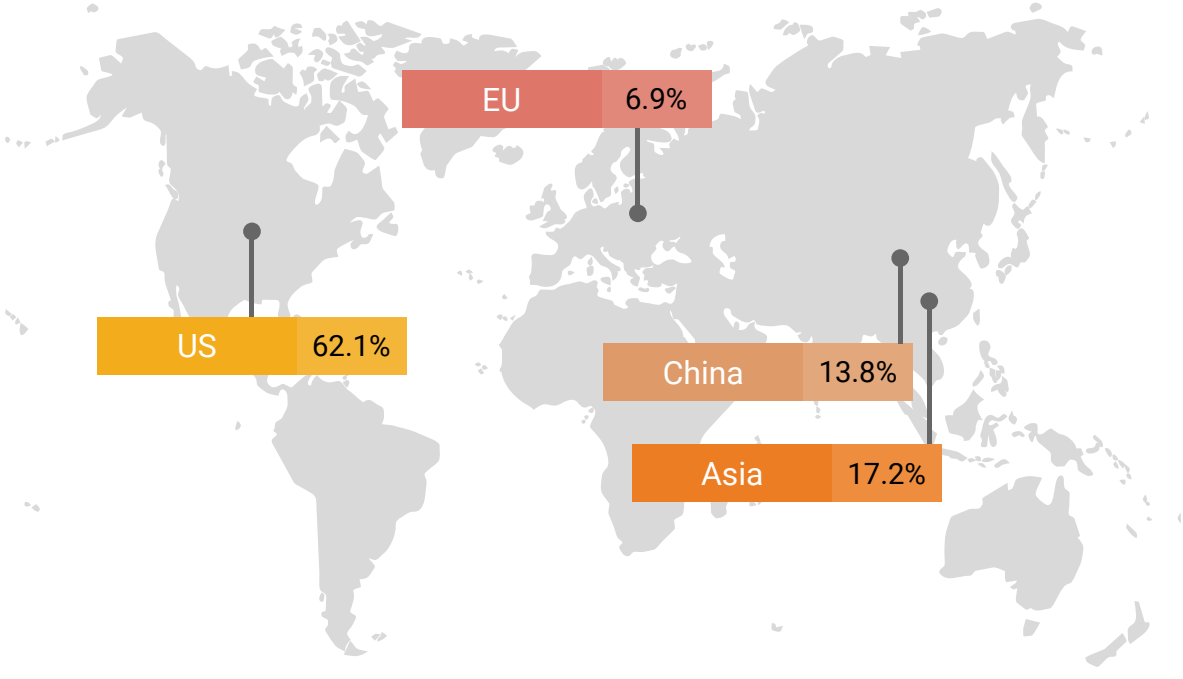
The United States leads the AI race on the level of Contract Research Organizations as well, with 42.9% of CROs being based in the US. It is followed by the European Union with around 29%. The other 9.5% have their headquarters in the UK. China represents only 4.8% of the AI-interested CROs, which would probably increase in the following years due to Chinese strategy on AI implementation and large investments in the AI industry.

31 Pharma Corporations Applying Advanced AI in Healthcare and Drug Discovery



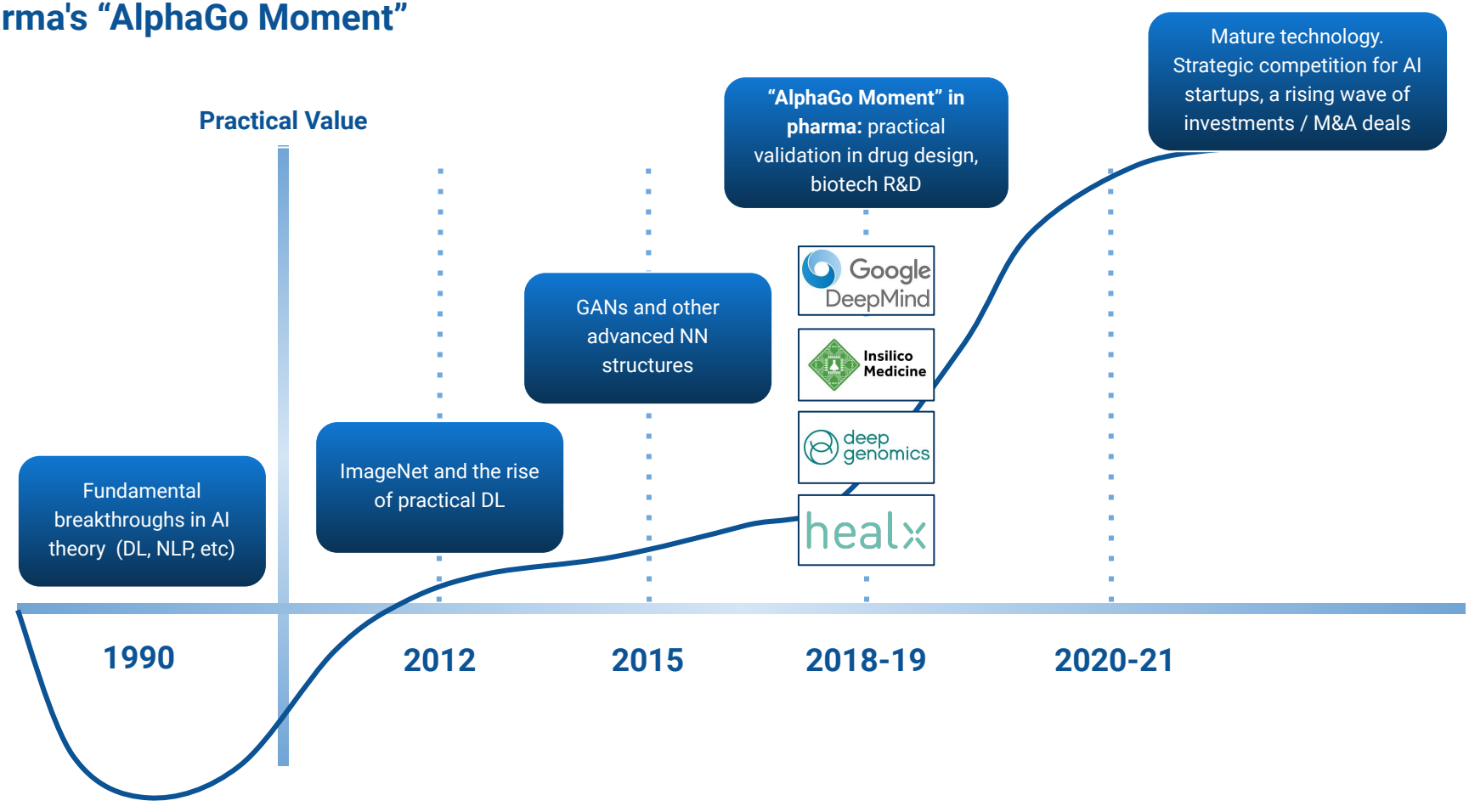
The industry is seeing an increasing level of regional diversification. Whereas historically the US has dominated the AI for Drug Discovery race in terms of the number of AI companies, the volume of investments and number of industry specialized conferences, from 2019 we are seeing an increased level of activity from the UK, Switzerland and China.

29 Leading Tech and Chemical Corporations: Regional Proportion



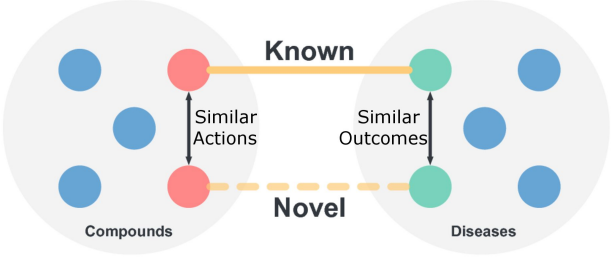
The US is the leader according to the number of tech corporations applying advanced AI in healthcare and drug discovery. EU leads the world in terms of the number of Chemical Corporations. The second biggest figure can be observed in Asia while the EU is in the third place. This is sensible within the context of the recent increase in the chemical industry in EU that overweight the US and Asian markets of chemical substances and related products. A lot of these chemical corporations are participating in cooperation and partnerships that are aimed at drug discovery and are related to pharmaceutical issues.

Pharma's “AlphaGo Moment”



Heal-x used AI-driven drug repurposing to identify drug candidate for Fragile X syndrome and advance to phase 2a clinical trial in just 18 months.

2018



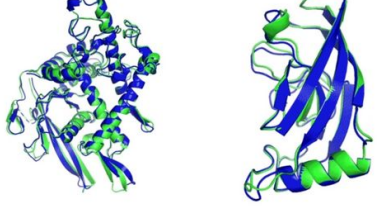
Deep Genomics AI-driven platform predicted novel target and oligonucleotide candidate for Wilson disease in under 18 months.



2019

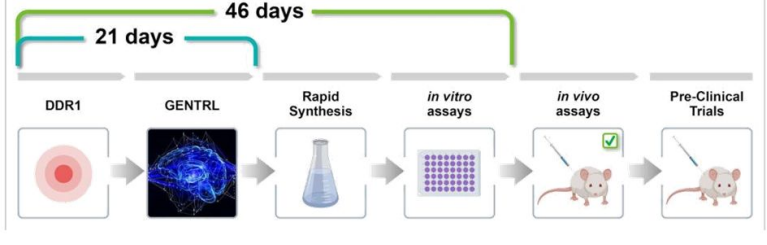
DeepMind's AlfaFold learns to predict protein's 3D shape from its amino-acid sequence, a 50 year-old grand challenge in biology.

2020



Experimental Result
Computational Prediction

Insilico Medicine applied generative adversarial network-based system GENTRL for rapid identification of potent DDR1 Kinase inhibitors within 21 days.



Technological Advancements Defining the Market

2021

Insilico Medicine achieved industry-first fully AI-based Preclinical Candidate. Initial hypothesis was build via DNN analysis of omics and clinical datasets of patients. After that company used its AI PandaOmics engine for target discovery, analyzing all relevant data, including patents and research publications with NLP algorithms. In the next step Insilico has applied its generative chemistry module (Chemistry42) in order to design a library of small molecules that bind to the novel intracellular target revealed by PandaOmics. The series of novel small molecules generated by Chemistry42 showed promising on target inhibition. One particular hit ISM001 demonstrated activity with nanomolar (nM) IC50 values.

Insilico Medicine 英科智能

Preclinical candidate Selected (PCC)

Insilico → Traditional Approach

Disease Hypothesis & Target Identification	Target-to-hit	Hit-to-lead	Lead optimization and Candidate Validation
1 week	2 months	4 months	11 months
< $ 50k N/A	$ 200k $ 94M	$ 400k $ 166M	$ 200k $ 414M
Up to Decades	1 year	1.5 years	2 years

Phase 1 → Phase 2 → Phase 3 → Submission to launch

When optimizing ISM001, Insilico managed to achieve increased solubility, good ADME properties, and no sign of CYP inhibition — with retained nanomolar potency. Interestingly, the optimized compounds also showed nanomolar potency against nine other targets related to fibrosis. The efficacy and a good safety of the molecule led to its nomination as a pre-clinical drug candidate in December 2020 for IND-enabling studies. The phase I clinical trial for the novel drug candidate is planned for December 2021.

Source: Insilico Medicine

Executive Summary



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This Report at a Glance

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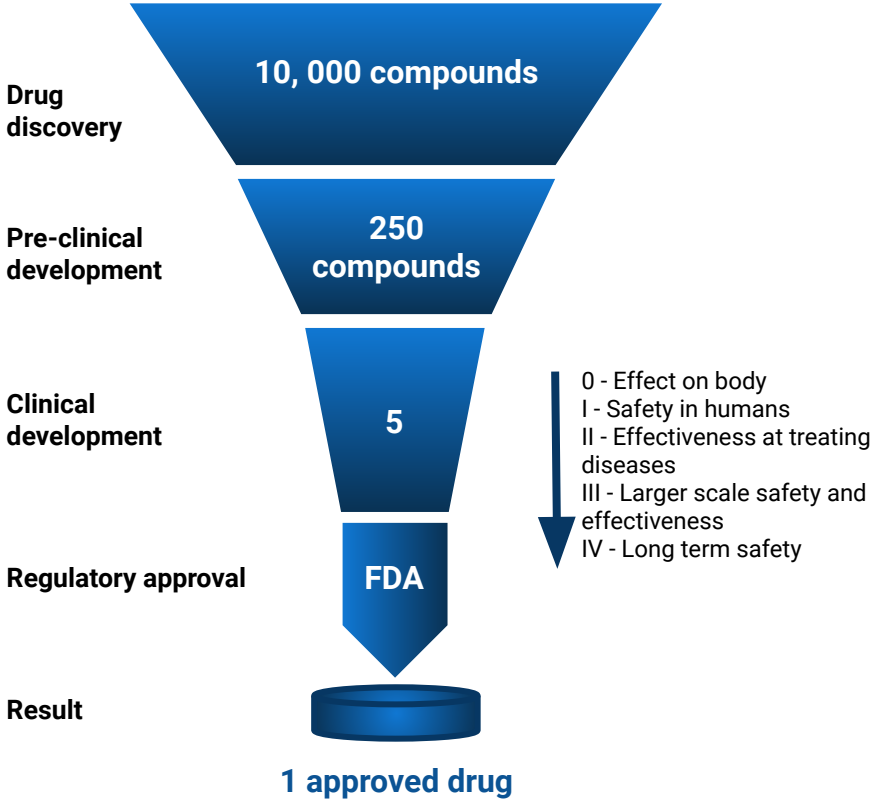
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Alongside investment and business trends, the report also provides technical insights into some of the latest achievements in the AI application and research.

This report has been put together taking into account the unprecedented global COVID19 pandemics, which substantially impacted every industry on the planet, pharma and biotech not being an exception. Quite expectedly, COVID19 brought about quite a few opportunities for the drug makers and vaccine developers and in general, it catalyzed more rapid progress in the pharmaceutical AI space as well. 2021 continued a clearly visible trend of high cooperation between pharmaceutical companies and AI technology. Finishing Q2 with 41 collaborations which included lots of open science project and huge business deals, 2021 looks like a year of a sustainable growth and deeper usage of AI in pharmacy. However, COVID19 also created major challenges for the pharma industry, such as disruptions in clinical trials and regular research projects and lab workflows. However, our findings related to COVID19 impact on the biotech investment landscape will be presented in the upcoming report, dedicated specifically to this issue.

Pharma Efficiency: Challenges



10 years + $2.6 bln = 1 new drug

It takes on average over 10 years to bring a new drug to market. As of 2014, according to Tufts Center for the Study of Drug Development (CSDD), the cost of developing a new prescription drug that gains market approval is approximately $2.6 billion. This is 145% increase, correcting for inflation, comparing to the same report made in 2003.

The pharmaceutical industry is in a terminal decline, and the returns on new drugs that do get to market do not justify the massive investments that Pharma currently puts into R&D anymore.

The solution to this problem comes from three key strategies:

- evolution of business models towards more collaboration and pipeline diversification early
- implementation of AI as a universal shift towards data-centric drug discovery
- discovery of new therapeutic modalities (biologics, therapies etc.)

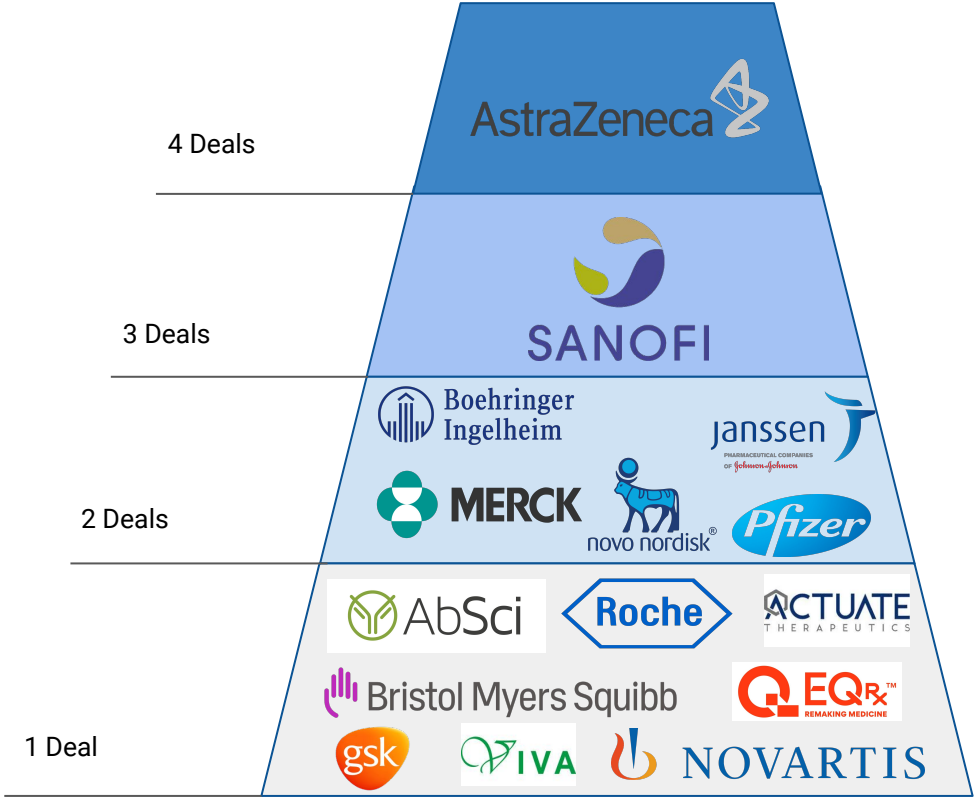
Source: Endpoints News, ePharmacology

Big Pharmas' AI-focused partnerships in Q2 2021

In this report we have profiled 300 actively developing AI-driven biotech companies. A steady growth in the AI for Drug Discovery sector can be observed in terms of substantially increased amount of investment capital pouring into the AI-driven biotech companies ($2.28B in HY 2020 against $2.93B in HY 2021), the increasing number of research partnerships between leading pharma organizations and AI-biotechs, and AI-technology vendors, a continuing pipeline of industry developments, research breakthroughs, and proof of concept studies, as well as exploding attention of leading media and consulting companies to the topic of AI in Pharma and healthcare.

Some of the leading pharma executives increasingly see AI as not only a tool for lead identification, but also a more general tool to boost biology research and identify new biological targets and develop novel disease models.

The main focus of AI research for today is still on small molecules as a therapeutic modality.



Application of AI for Advanced R&D to Address Pharma Efficiency Challenges

Target Discovery and Early Drug Discovery

- Analyze data sets, form hypotheses and generate novel insights
- Identify novel drug candidates
- Analyze data from patient samples in both healthy and diseased states to generate novel biomarkers and therapeutic targets
- Predict binding affinity and other pharmacological properties of molecules
- Allow filtering for drug-like properties of molecules
- Reduce complexity in protein design

Clinical Trials

- Optimize clinical trial study design
- Transform diverse streams of biomedical and healthcare data into computer models representative of individual patients
- Deliver personalized medicine at scale by revealing optimal health interventions for individual patients
- Analyze medical records to find patients for clinical trials
- Automate matching cancer patients to clinical trials through personal medical history and genetic analysis
- Improve pathology analysis
- Identify patients that would benefit from novel therapies

Design and Processing of Preclinical Experiments

- Reduce time, money, and uncertainty in planning experiments
- Decode open- and closed-access data on reagents and get actionable insights
- Automate selection, manipulation, and analysis of cells
- Expedite development of cell lines and automate manufacturing of cellular therapeutics
- Automate sample analysis with a robotic cloud laboratory

Repurposing of Existing Drugs

- Rapidly identify new indications for many known drugs
- Match existing drugs with rare diseases
- Conduct experimental biology at scale by testing 1000+ of compounds on 100+ of cellular disease models in parallel
- Generate novel biomarkers and therapeutic targets

Aggregation and Synthesis of Information

- Extract knowledge from literature
- Generate insights from thousands of unrelated data sources
- Improve decision-making
- Eliminate blind spots in research
- Identify competitive whitespace

Business Activity

The business activity has been increasing in the pharmaceutical AI space over Q1-Q2 2021, judging by an increased number of transactions and partnership announcements in this period.

The most significant deals and collaborations in 2021 include:

- **Insitro** has raised $400M for machine learning-powered drug discovery efforts. The financing was led by the **Canada Pension Plan Investment Board** with additional backing from **Andreessen Horowitz**, **Casdin Capital**
- **Valo Health** announced the final closing of its Series B at $300M, including a $110 million investment from Koch Disruptive Technologies (KDT). This brings the overall funding of Valo to over $450M to accelerate the creation of life-changing drugs
- **Amgen** — **Mila** partnership that permits Amgen to expand its knowledge of AI and deep learning by interacting and engaging with experts in Mila's unique ecosystem
- **Iktos** announced the application of Iktos AI for de novo design to selected **Pfizer** small-molecule discovery programs
- **ZebiAI Therapeutics** — **Relay Therapeutics**: Relay bought ZebiAI for $85M upfront and a further $185M in potential milestone payments
- **Roivant** — **Silicon Therapeutics**: Roivant bought Silicon for $450M along with its physics-based platform for in silico small-molecule drug design. This platform will be integrated with Roivant's machine learning developments
- **Nvidia** and **Schrödinger** have partnered in the hopes of increasing the speed and accuracy of their molecule prediction software of Schrödinger
- **BenevolentAI** and **AstraZeneca** have extended their partnership to achieve collaboration milestone with novel AI-generated chronic kidney disease target
- **Lantern Pharma** and **Actuate Therapeutics** have entered into collaboration to generate novel intellectual property that will be jointly owned by the companies

Partnerships like these provide a huge effect on Pharma industry and are needed in case if a company intends to become a leader in the ongoing competition.

Major Observations for Q1-Q2 2021: Key Business Takeaways

1. **The segment of pharmaceutical AI continues consolidation** with the increasing number of later stage mega-rounds, including those of Insitro ($400M), Valo Health ($300M), Exscientia ($265M), Insilico Medicine ($255M) and others. The AI startups pack is clearly differentiating into the leaders, who developed substantial resources, financial leverage, and technological advantage, and others lagging behind — companies with less resources or less mature technology and scientific assets. The latter are usually focused on narrow therapeutic or technological niches, and are following service-oriented business models.
2. Notably, biotech industry is embracing a new powerful trend of bringing companies to public markets via Special Purpose Acquisition Companies (SPACs). Valo Health has been a most recent example of an AI-driven company having exited via SPAC with more than $500M raised.
3. **Pharmaceutical AI sector is "heating up"**, and becomes a lucrative area for specialized biotech investors as well as investor organizations just entering the pharma space with a goal of including high-risk/high-return companies in their investment portfolios. This is backed by several observations, including an ongoing increasing investment activity in this sector during half year 2021, emergence of SPAC pathway to public markets, the increasing rush among leading pharma and contract research organizations (CROs) to compete for partnerships with AI-driven companies, and the increasing amount of proof-of-concept breakthroughs, confirming that AI technology has achieved substantial maturity to be able to bring tangible value for drug discovery — far beyond a simple optimization gain.
4. **Big pharma and contract research organizations increasingly compete for AI partnerships**, and continue building in-house AI workflows — driven by rapidly emerging evidence of the AI tech feasibility and innovation potential. A number of highly notable proof-of-concept results has been announced during half year 2021, including Insilico Medicine's groundbreaking discovery of novel target and preclinical drug candidate for Idiopathic Pulmonary Fibrosis (IPF).
5. **COVID-19 pandemics appears to be a positive catalyst for the acceleration of the AI adoption** by the pharmaceutical organizations. This is primarily stipulated by the necessity to rapidly process vast amounts of data, and come up with innovations under strict deadlines. Therefore, this urgency pushed companies and investors into more opportunistic projects than ever before.

Key Technology Takeaways

1. AI is regarded by some top executives at big pharma (**GSK and others**) as **a tool to uncover not only new molecules, but also new targets**. Ability of deep neural networks to build ontologies from multimodal data (e.g. "omics" data) is believed to be among the most disruptive areas for AI in drug discovery, alongside with data mining from unstructured data, like text (using natural language processing, NLP).
2. There is **a considerable trend for "AI democratization"** where various machine learning/deep learning technologies become available in pre-trained, pre-configured "of-the-shelf" formats, or in relatively ready-to-use formats — via cloud-based models, frameworks, and drag-and-drop AI-pipeline building platforms (for example, KNIME). This is among key factors in the acceleration of AI adoption by the pharmaceutical organizations — where a non-AI experts can potentially use fairly advanced data analytics tools for their research.
3. **Proof-of-concept projects keep yielding successful results** in research studies, and in the commercial partnerships alike. For example, companies like Recursion Pharmaceuticals, Insilico Medicine, Deep Genomics, and Exscientia achieved important research milestones using their AI-based drug design platforms.

Obstacles That Still Remain

1. **Global shortage of AI talent** continues to be a serious challenge for the biopharma industry, repeating the trend from our previous reports. While big pharmaceutical companies invest substantial capital in recruitment of AI specialists, still the majority of them are acquired by large tech corporations (Google, Amazon, Alibaba, Tencent, Baidu etc.) However, a growing wave of specialized university programs and courses, geared towards data science and AI application, is projected to address this issue to certain extent in the coming years.
2. **Lack of available quality data is still a challenge for the unleashing full potential of deep learning technologies.** Numerous variations of deep learning (DL) are believed to be the most lucrative area of AI for applications such as drug discovery and clinical research. The key challenge is that DL algorithms are "data-greedy", while big data in biotech is not always well-versed for modeling, or is inaccessible due to privacy reasons.
3. **Ethical, legal, and regulatory issues for AI adoption in the pharmaceutical sciences.** This set of challenges is related to the previous point, but also includes other questions — AI explainability, patentability of AI-generated results, non-optimal regulations in various countries, slowing down the progress and adoption of AI technologies in general, and in the pharmaceutical industry in particular.

AI in the Global Context

US is a main player in AI industry. In the beginning of AI implementation, US was a pioneer and then the main player with the greatest number of companies using AI to force R&D, research centres and institutes, and investments. However, we observe the increased level of the UK and EU activity through big corporations that use AI to reorganise drug discovery and in launching government initiatives. It is also important to note a great increase in activity from the Asia-Pacific region generally, and particular from China — AI superpower.

China engages in extensive investment activity. In particular, it has promised to invest $5B in AI. Tianjin, one of the biggest municipalities, is going to invest $16B in its local AI industry, and the Beijing authorities will build $2.12B AI development project. China also has at least ten privately owned AI startups valued at more than US$1B. Moreover, China has been heavily investing in biotech R&D, although lately a serious decrease in Chinese investment in US biotech startups has been observed which can be explained by the trade conflicts between the US and China.

China plans to become the world AI leader by 2030, according to the AI Strategic Plan released in July 2017. The analysis of the the Asia-Pacific region has shown that the main forcers of AI implementation include Saama Technologies, Inc., a leading clinical data analytics company. It has announced a collaboration with researchers at the Tufts Center for the Study of Drug Development to ascertain how biopharmaceutical companies optimize automation and information technologies, including machine learning and neural networks, to support the research and development of new therapeutics. Moreover, XtalPi provides a huge number of talent to work with machine learning, create drug discovery and development applications that predict the properties of small molecules. Another innovators of Asian AI industry are Cytlimic and Fujitsu that offer software for predicting how well compounds will bind with each other and proteins.

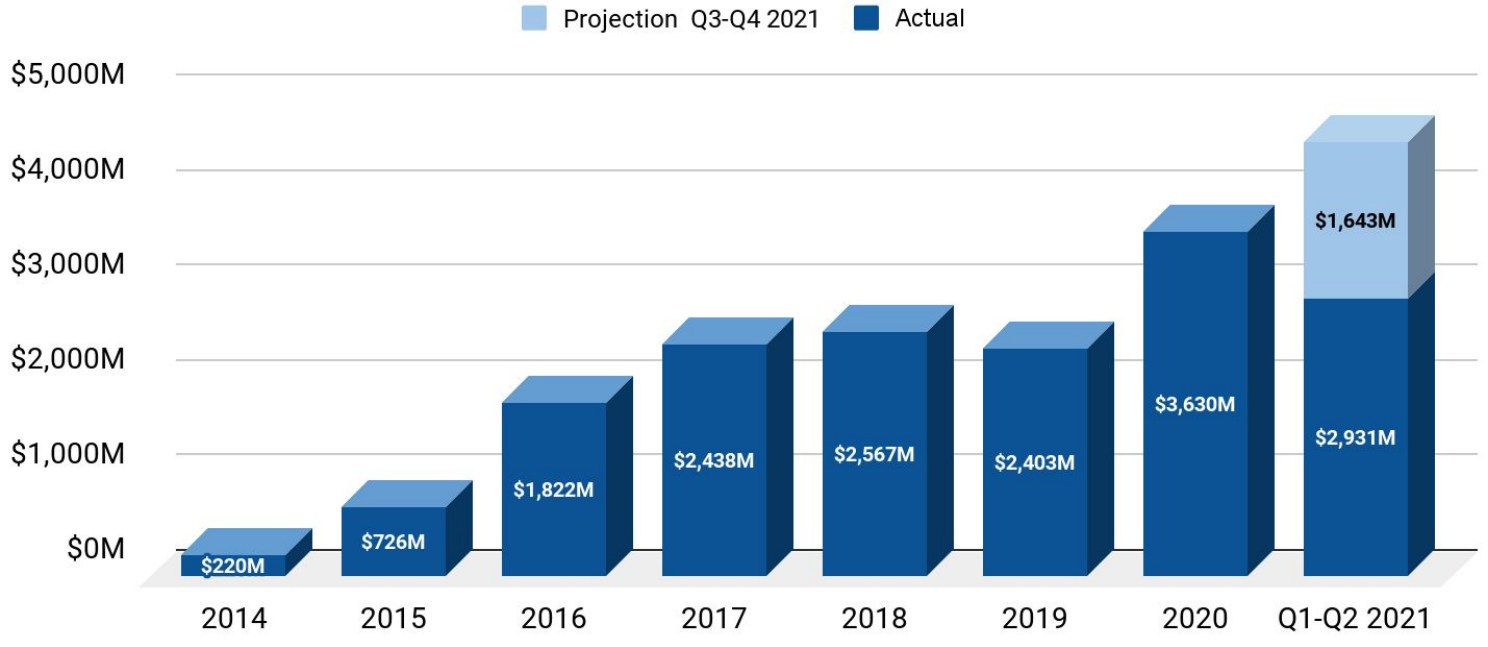
Europe has traditionally been a strong breeding ground for biopharma activity, with some recent large valuations and mega deals. The UK and EU activity in the pharmaceutical AI race is mainly boosted by Novartis that announced the partnership with Hewlett Packard Enterprise, US-based company to advance Novartis global health efforts (June, 2021). Furthermore, UK-based BenevolentAI and AstraZeneca achieved the collaboration milestone with novel AI-generated chronic kidney disease target identified through the Benevolent Platform and AstraZeneca's scientific expertise and rich datasets. One more UK-based company, Lifebit Biotech Ltd, has partnered with Boehringer Ingelheim to utilise AI for the detection and early reporting of global disease outbreaks using real-world data. Iktos, France-based company utilizing AI for drug design has announced two partnerships in 2021. The first one was entered into with Kadmon to enable the rapid and cost-effective design of novel drug candidates, while the second was concluded with Pfizer to apply Iktos AI-driven de novo design software to a number of Pfizer’s small-molecule programs. This all demonstrate that Pharma is increasingly turning to AI to transform the drug discovery process.

Business Activity: Overview



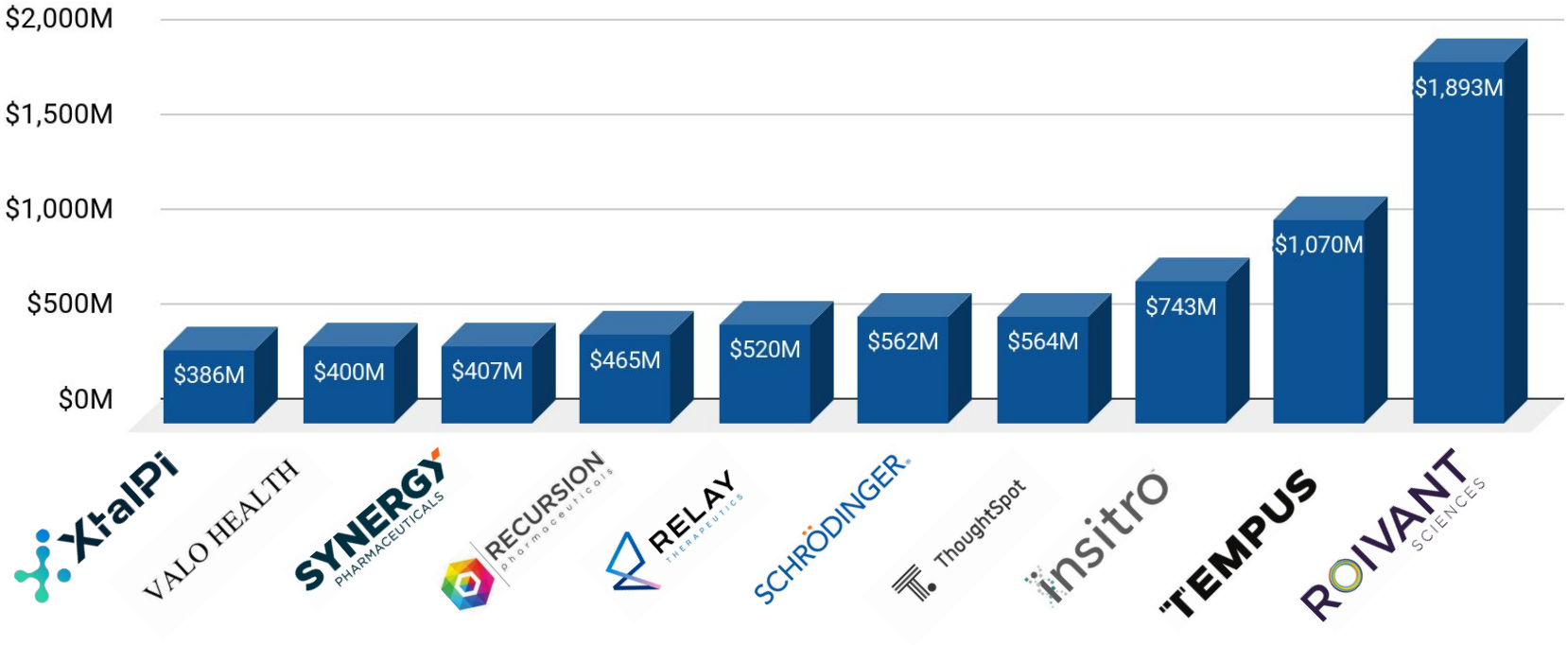
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Dynamics of AI in Pharma Investments



There has been a strong increase in the amount of capital invested in AI-driven pharma companies since 2014. In the past 7 years, the annual amount of investments has increased 5 times (to $2.93B in total as of June 2021). In 2020, the flow of investments increased by 50% as compared to the previous year. At the same time, in Q1-Q2 2021 the amount of investments has reached $2931.06M that is 80.75% compared to the amount in 2020. There is a notable trend of increasing the average investments amount from $36.61M in 2020 to $59.81M within Q1-Q2 2021.

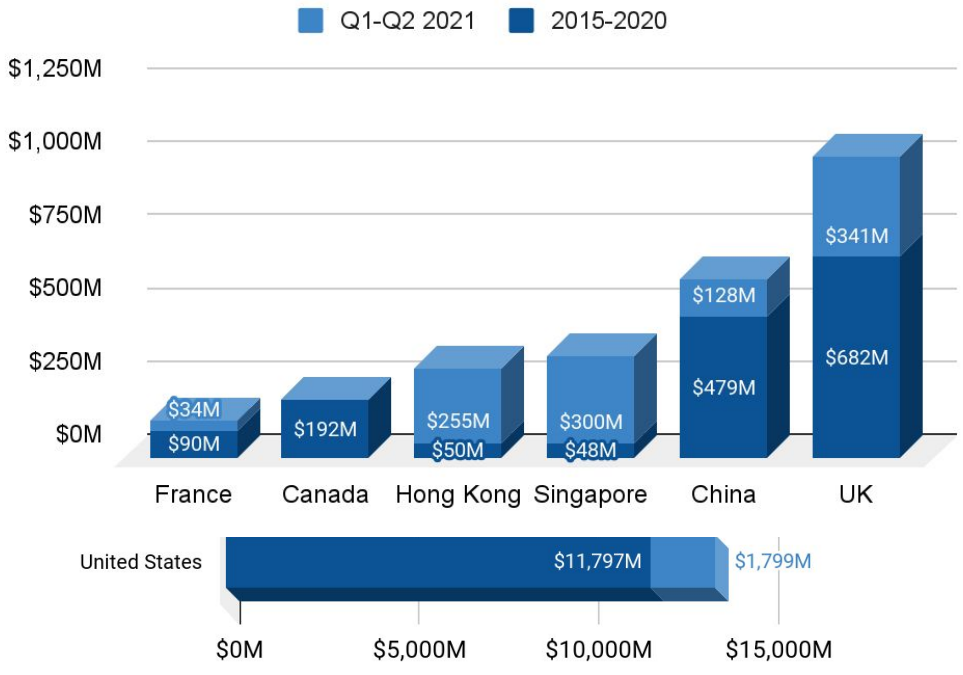
Top-10 AI Companies by Total Investments in Q1-Q2 2021



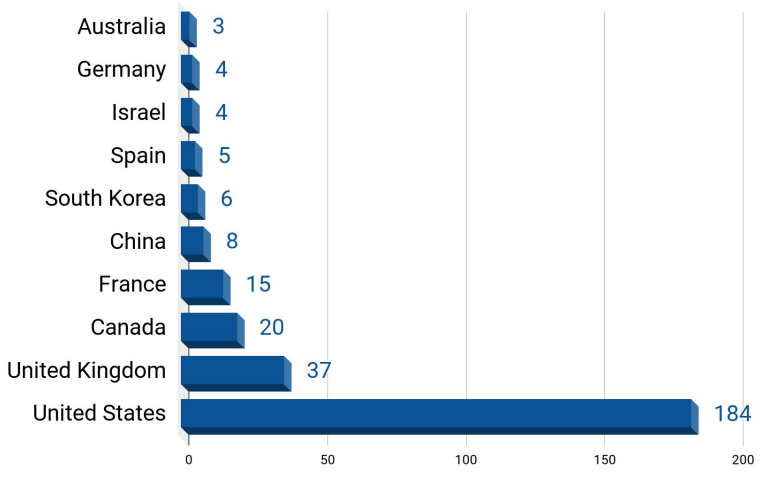
The chart shows the top 10 AI-driven drug discovery companies sorted by total funding raised by the end of June 2021. Roivant Sciences, a leader in artificial intelligence and precision medicine, is now at the top of the list. Having completed the business combination with Montes Archimedes Acquisition Corp. in May 2021, the company has the total funding raised amounting to $1.89B. Roivant Sciences is expected to go public in Q3 2021 under the ticker symbol “ROIV”. Tempus, Insitro and ThoughtSpot are new companies in the list due to late-stage mega-rounds during half year 2021.

Top-10 Countries in AI for Drug Discovery Sector in Q1-Q2 2021

Total Investments by Country

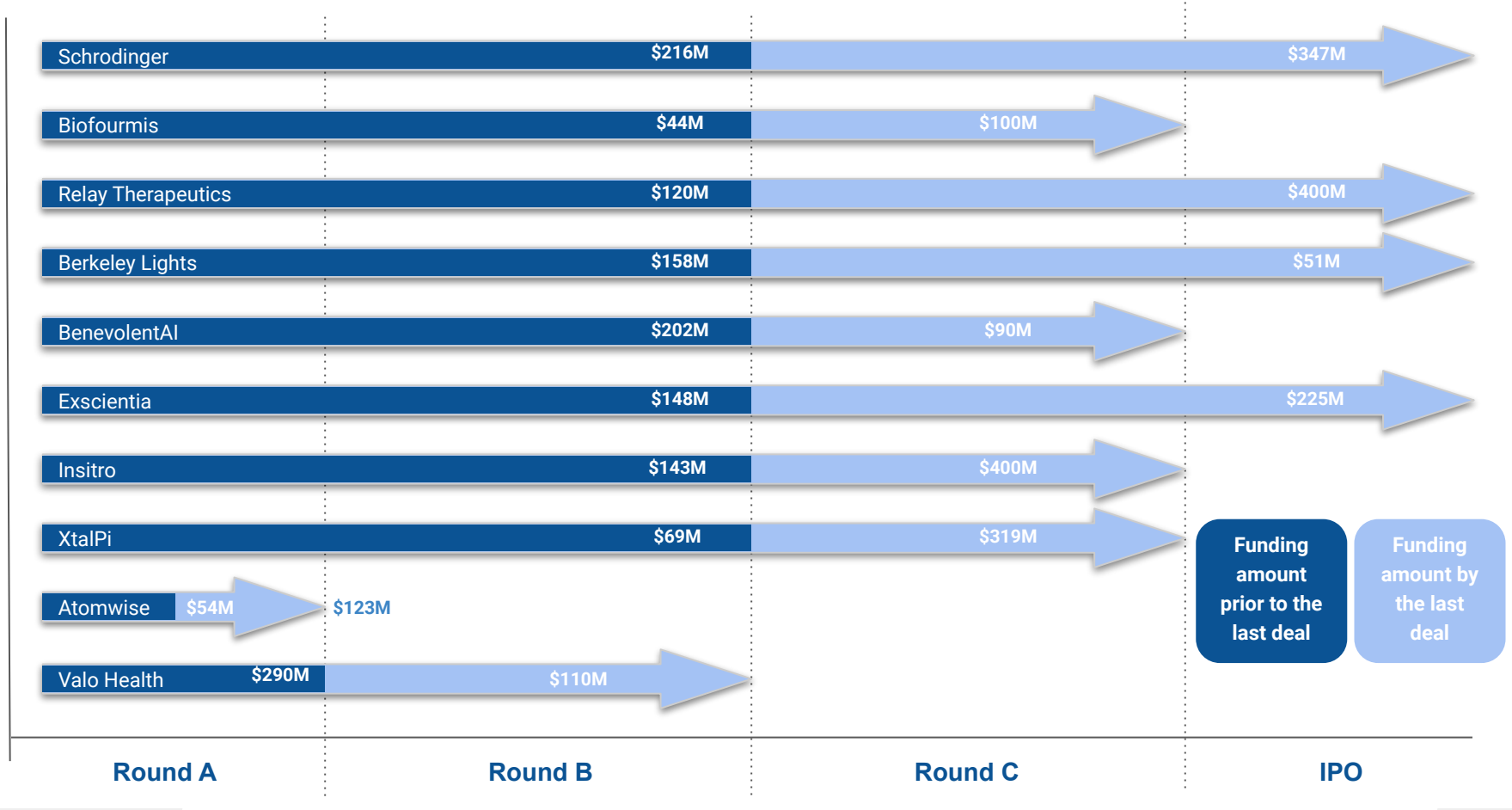


Number of Companies by Country

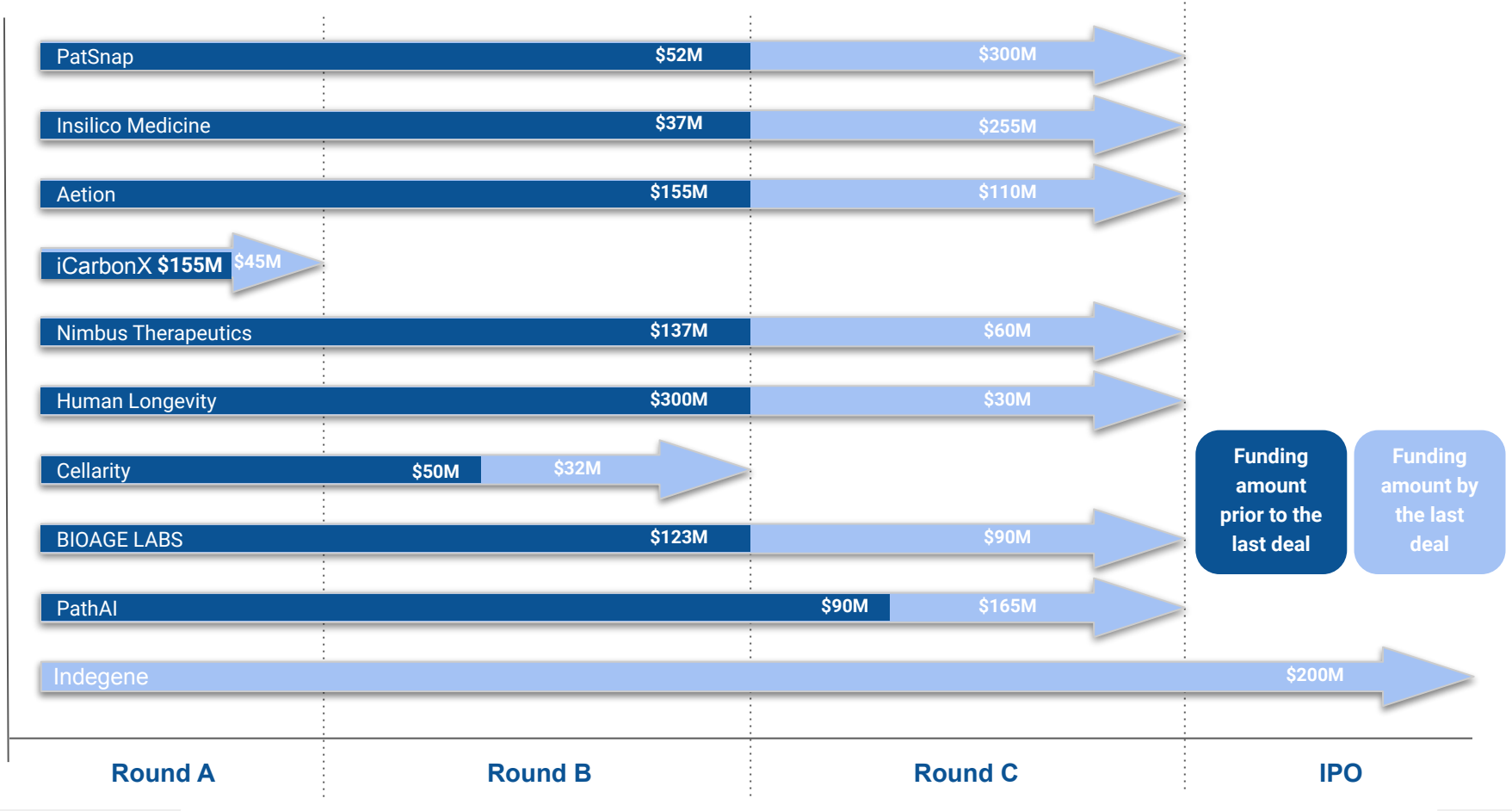


The chart to the left represents the distribution of funding received by companies located in 10 countries with largest investment in AI for Drug Discovery sector as of half year 2021. The USA is an unconditional leader with a total amount of investments of $13.59B as of June 2021. The UK is the second-most invested region with total investments of $1.02B overall and $341.32M raised in half year 2021. The most significant increase in total amount of investments is observed in Hong Kong and Singapore. This tendency could be traced on the right-side chart, as well, which shows the top 10 countries by the number of companies applying AI for drug discovery.

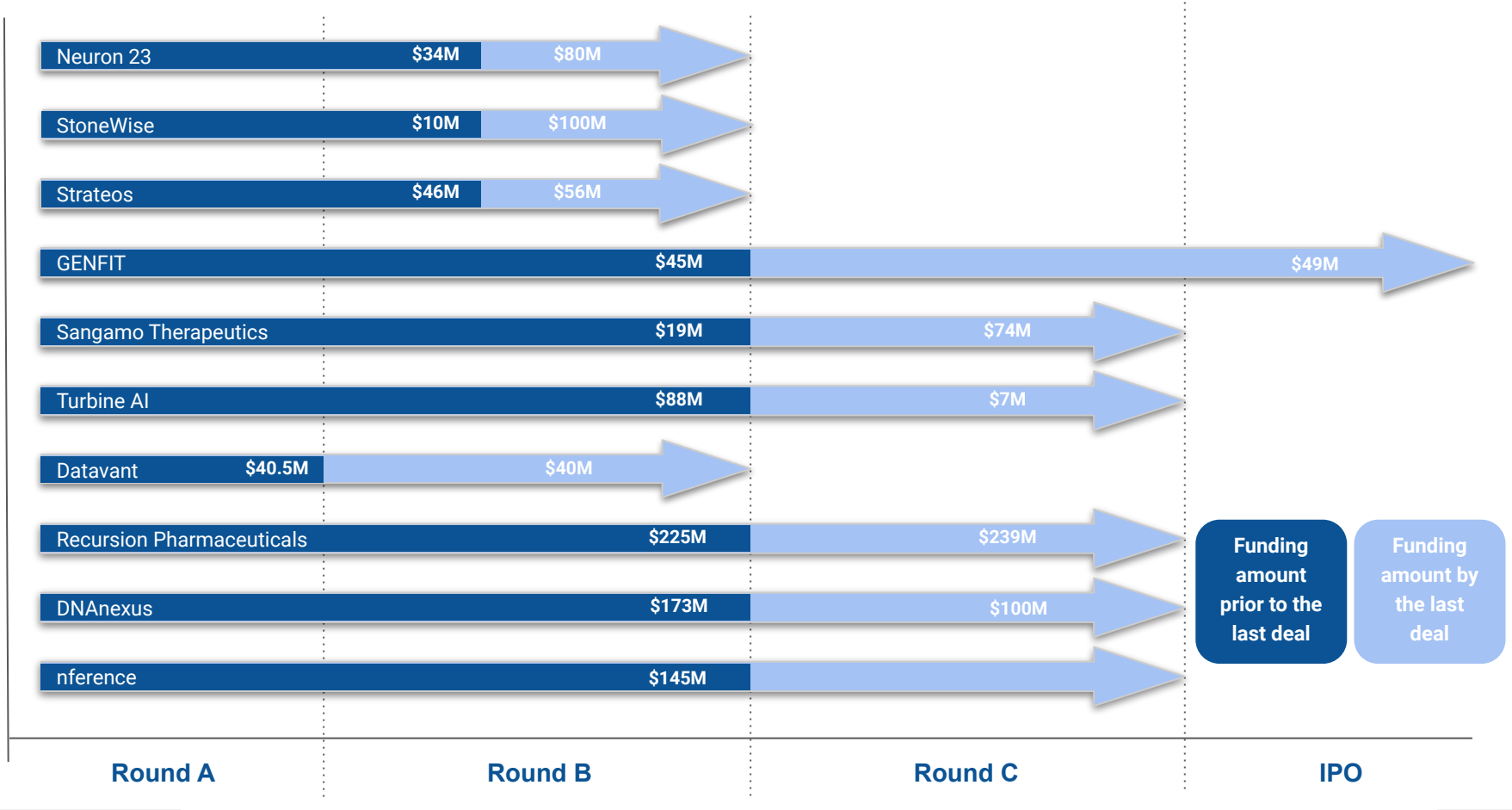
Leading Companies by Amount and Stage of Funding



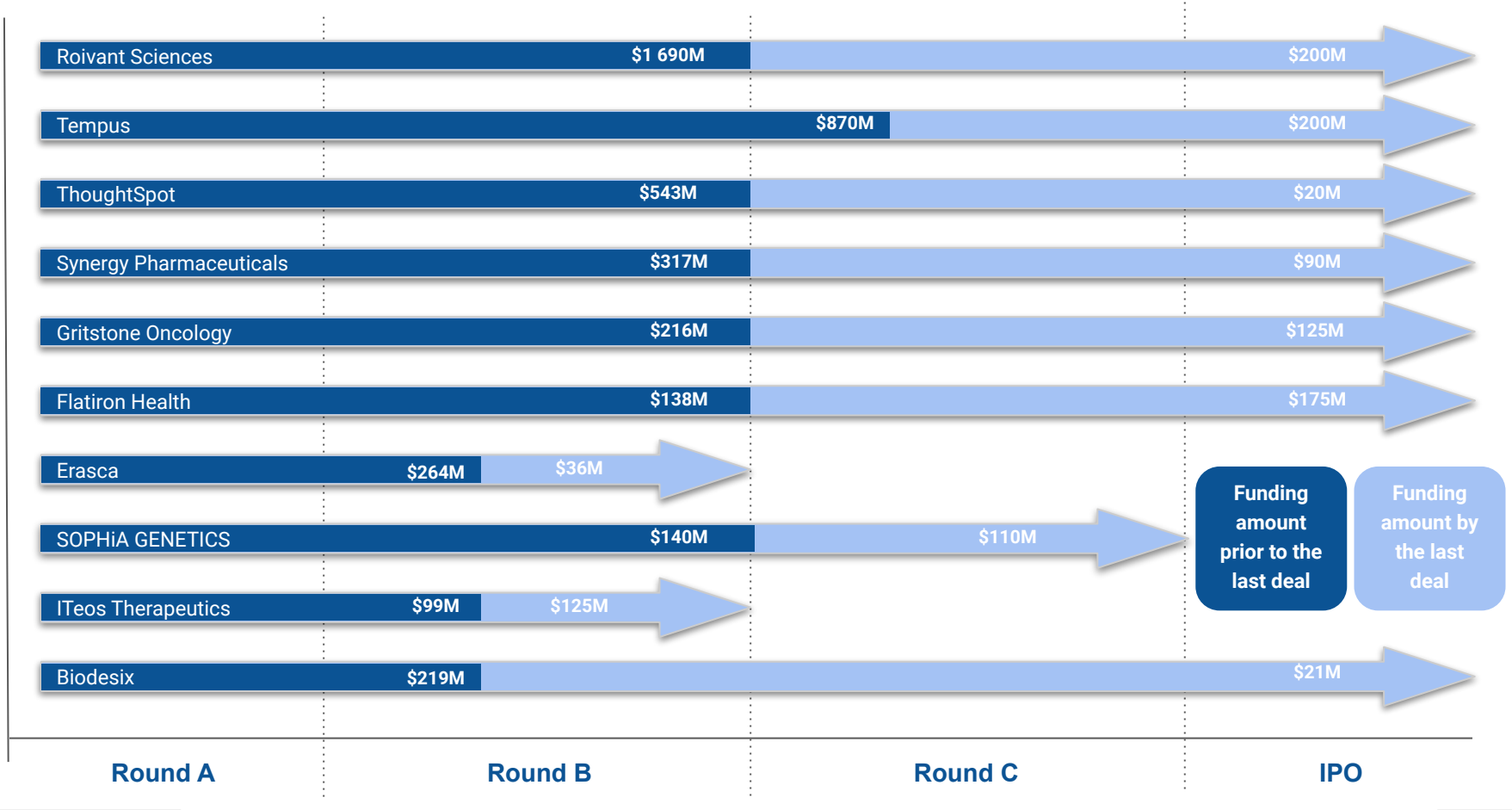
Leading Companies by Amount and Stage of Funding



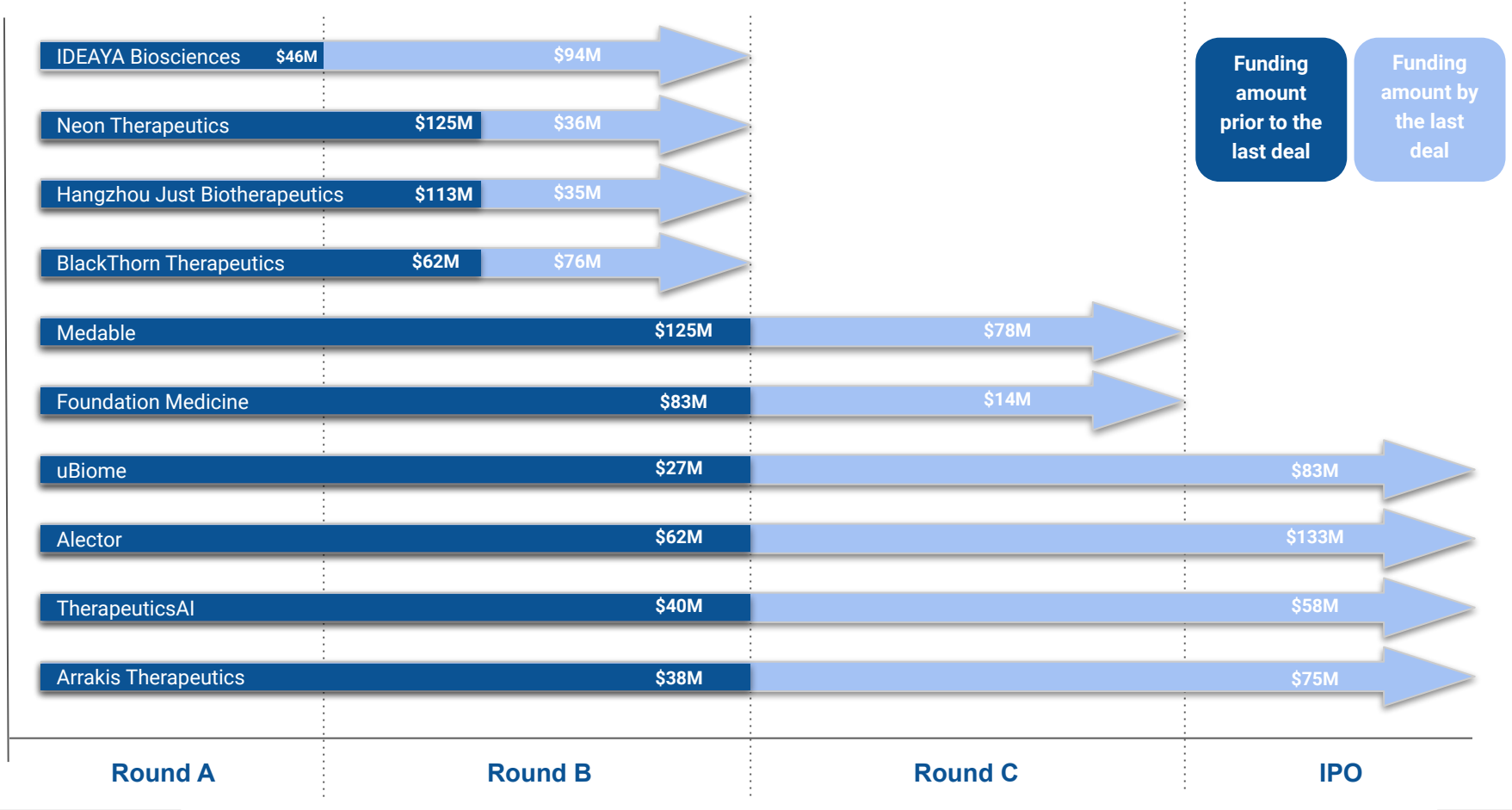
Leading Companies by Amount and Stage of Funding



Leading Companies by Amount and Stage of Funding



Leading Companies by Amount and Stage of Funding



50 Leading Investors in Pharmaceutical AI



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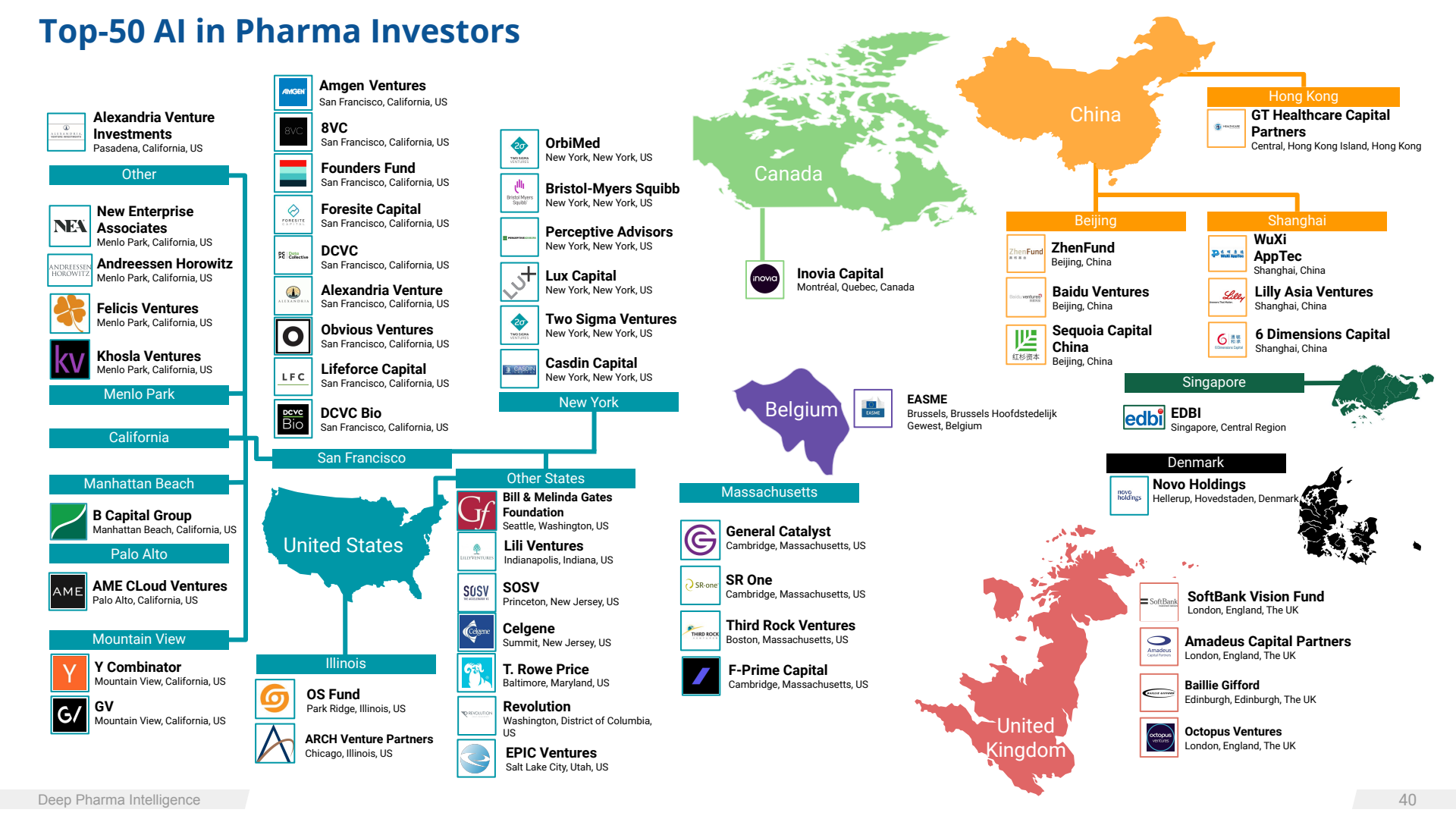
50 Leading Investors in AI for Drug Discovery Sector

1	GV
2	Casdin Capital
3	DCVC
4	Y Combinator
5	Lux Capital
6	WuXi AppTec
7	Andreessen Horowitz
8	EASME - EU Executive Agency for SMEs
9	Lilly Asia Ventures
10	OS Fund
11	AME Cloud Ventures
12	ARCH Venture Partners
13	Felicis Ventures
14	Alexandria Venture Investments
15	Tencent
16	Third Rock Ventures
17	ZhenFund
18	Amadeus Capital Partners
19	Bill & Melinda Gates Foundation
20	Celgene
21	EDBI
22	F-Prime Capital
23	Foresite Capital
24	Founders Fund
25	Inovia Capital

50 Leading Investors in AI for Drug Discovery Sector

26	New Enterprise Associates
27	Khosla Ventures
28	Perceptive Advisors
29	SoftBank Vision Fund
30	Sequoia Capital China
31	8VC
32	T. Rowe Price
33	6 Dimensions Capital
34	Amgen Ventures
35	Baidu Ventures
36	Baillie Gifford
37	General Catalyst
38	B Capital Group
39	Bristol-Myers Squibb
40	DCVC Bio
41	EPIC Ventures
42	GT Healthcare Capital Partners
43	Obvious Ventures
44	Lifeforce Capital
45	Novo Holdings
46	Octopus Ventures
47	OrbiMed
48	SOSV
49	Revolution
50	Two Sigma Ventures

Top-50 AI in Pharma Investors



Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
GV	12 AI for Drug Discovery Companies	19	Alector, Arrakis Therapeutics, BlackThorn Therapeutics, Celsius Therapeutics, DNAnexus, Gritstone Oncology, IDEAYA Biosciences, Insitro, Owkin, Relay Therapeutics, Schrödinger, ZappRx
Casdin Capital	10 AI for Drug Discovery Companies	12	Alector, Arzeda, Celsius Therapeutics, Clover Therapeutics, Exscientia, Flatiron Health, Gritstone Oncology, Insitro, Recursion Pharmaceuticals, Relay Therapeutics
Y Combinator.	10 AI for Drug Discovery Companies	11	Arpeggio Bio, Athelas, Atomwise, HistoWiz, Menten AI, Notable Labs, PostEra, Reverie Labs, Strateos, uBiome
SoftBank Vision Fund	8 AI for Drug Discovery Companies	9	Biofourmis, Datavant, Exscientia, Insitro, PatSnap, Relay Therapeutics, Roivant Sciences, XtalPi
WuXi AppTec	8 AI for Drug Discovery Companies	9	Arrakis Therapeutics, DNAnexus, Engine Biosciences, Insilico Medicine, Insitro, Schrödinger, Strateos, Verge Genomics
8VC	6 AI for Drug Discovery Companies	9	BigHat Biosciences, Notable, PathAI, ProteinQure, uBiome, Unlearn.AI
Alexandria Venture Investments	6 AI for Drug Discovery Companies	7	Arrakis Therapeutics, Celsius Therapeutics, GNS Healthcare, Gritstone Oncology, IDEAYA Biosciences, Insitro
AME Cloud Ventures	6 AI for Drug Discovery Companies	10	Atomwise, BigHat Biosciences, BIOAGE LABS, Molecule.one, Recursion Pharmaceuticals, Strateos
Andreessen Horowitz	6 AI for Drug Discovery Companies	10	Aria Pharmaceuticals, BigHat Biosciences, BIOAGE LABS, Erasca, Genesis Therapeutics, Insitro
Felicis Ventures	6 AI for Drug Discovery Companies	11	BIOAGE LABS, Genesis Therapeutics, LabGenius, ProteinQure, Recursion Pharmaceuticals, Spring Discovery

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
OS Fund	6 AI for Drug Discovery Companies	7	Aria Pharmaceuticals, Arzeda, Emerald Cloud Lab, Human Longevity, uBiome, Verge Genomics
ZhenFund	6 AI for Drug Discovery Companies	8	Deep Intelligent Pharma, HistoWiz, Spring Discovery, uBiome, Xbiome, XtalPi
Bill & Melinda Gates Foundation	5 AI for Drug Discovery Companies	5	Atomwise, Exscientia, Hangzhou Just Biotherapeutics (Just China), Recursion Pharmaceuticals, Schrödinger
Foresite Capital	5 AI for Drug Discovery Companies	7	Aetion, Alector, DNAnexus, Insitro, Relay Therapeutics
Khosla Ventures	5 AI for Drug Discovery Companies	8	Atomwise, BIOAGE LABS, Deep Genomics, Menten AI, ThoughtSpot
Perceptive Advisors	5 AI for Drug Discovery Companies	5	Alector, DNAnexus, IDEAYA Biosciences, Neuron23, Relay Therapeutics
Amadeus Capital Partners	4 AI for Drug Discovery Companies	9	Antidote.me, Healx, Quibim, Synthace
ARCH Venture Partners	4 AI for Drug Discovery Companies	8	BlackThorn Therapeutics, Erasca, Hangzhou Just Biotherapeutics (Just China), Insitro
B Capital Group	4 AI for Drug Discovery Companies	5	Aetion, Atomwise, Insilico Medicine, Notable Labs
Celgene (BMS' subsidiary)	4 AI for Drug Discovery Companies	5	Arrakis Therapeutics, GNS Healthcare, Human Longevity, IDEAYA Biosciences

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
DCVC	4 AI for Drug Discovery Companies	11	Atomwise, Recursion Pharmaceuticals, Strateos, Unlearn.AI
EASME - EU Executive Agency for SMEs	4 AI for Drug Discovery Companies	5	Genialis, Genome Biologics, Mind the Byte, Quibim
EDBI	4 AI for Drug Discovery Companies	6	Aetion, Biofourmis, Engine Biosciences, Erasca
F-Prime Capital	4 AI for Drug Discovery Companies	5	BenchSci, Insilico Medicine, Notable, Owkin
Founders Fund	4 AI for Drug Discovery Companies	5	Datavant, Emerald Cloud Lab, Notable Labs, Roivant Sciences
Lifeforce Capital	4 AI for Drug Discovery Companies	5	Clover Therapeutics, Notable Labs, TARA Biosystems, Verge Genomics
Lilly Asia Ventures	4 AI for Drug Discovery Companies	7	Alector, Gritstone Oncology, Hangzhou Just Biotherapeutics (Just China), Insilico Medicine
Obvious Ventures	5 AI for Drug Discovery Companies	8	Inato, LabGenius, Medable, Recursion Pharmaceuticals
Tencent	4 AI for Drug Discovery Companies	7	Atomwise, iCarbonX, PatSnap, XtalPi
Third Rock Ventures	4 AI for Drug Discovery Companies	7	Celsius Therapeutics, Insitro, Neon Therapeutics, Relay Therapeutics

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
6 Dimensions Capital	3 AI for Drug Discovery Companies	5	Engine Biosciences, IDEAYA Biosciences, iTeos Therapeutics
Baidu Ventures	3 AI for Drug Discovery Companies	6	Atomwise, Engine Biosciences, Insilico Medicine
Baillie Gifford	3 AI for Drug Discovery Companies	5	Flatiron Health, Recursion Pharmaceuticals, Tempus
DCVC Bio	3 AI for Drug Discovery Companies	5	Frontier Medicines, Unlearn.AI, X-37s
General Catalyst	3 AI for Drug Discovery Companies	7	PathAI, Spring Discovery, ThoughtSpot
GT Healthcare Capital Partners	3 AI for Drug Discovery Companies	5	Exscientia, GT Apeiron Therapeutics, Ultromics
Inovia Capital	3 AI for Drug Discovery Companies	5	BenchSci, LabGenius, ProteinQure
Lux Capital	3 AI for Drug Discovery Companies	8	LabGenius, Recursion Pharmaceuticals, Strateos
OrbiMed	3 AI for Drug Discovery Companies	5	Alector, Erasca, Insilico Medicine
Sequoia Capital China	3 AI for Drug Discovery Companies	6	Deep Intelligent Pharma, PatSnap, XtalPi

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
SOSV	3 AI for Drug Discovery Companies	7	A2A Pharmaceuticals, Mendel.ai, Synthace
T. Rowe Price	3 AI for Drug Discovery Companies	6	Genesis Therapeutics, Insitro, Tempus
Two Sigma Ventures	3 AI for Drug Discovery Companies	6	Exscientia, PathAI
Amgen Ventures	3 AI for Drug Discovery Companies	4	Aetion, Alector, GNS Healthcare
Novo Holdings	2 AI for Drug Discovery Companies	5	Exscientia, Tempus
Octopus Ventures	2 AI for Drug Discovery Companies	5	Antidote.me, GTN
Revolution	2 AI for Drug Discovery Companies	5	Amplion, Tempus
Bristol-Myers Squibb	2 AI for Drug Discovery Companies	4	Exscientia, PathAI
New Enterprise Associates	2 AI for Drug Discovery Companies	6	Aetion, Tempus
EPIC Ventures	1 AI for Drug Discovery Companies	5	Recursion Pharmaceuticals

AI for Drug Discovery Market Timeline

The First AI Approaches — 2013-2015

- The first scalable AI approaches for Drug Discovery developed and several industry players with forward-thinking executives started launching pilot collaborations and making small investments.
- However, only few market players believed in the technology.

Criticism — 2016-2017

- Because AI is still a young approach within the life sciences, many pilot projects failed, creating a lot of criticism towards the use of deep learning for Drug Discovery and Advanced R&D.
- Since then the race for the acquisition of the best, AI startups began.
- Testing of the technology began.

Market Cap Growth — 2018

- Capitalization of the industry was continuously growing.
- Many bets of early investors appeared to be justified.
- Over the next several years, we expect to see VC firms and subsidiary funds focused solely on the AI for Drug Discovery subsector, and funds that invest in a maximally-diverse number of AI for Drug Discovery companies.

Transition from Quantity to Quality — 2019

- Transitioning from the quantity of AI-related collaborations, investments, and M&As to qualitative gains — first practical validations of previously conducted research might be appearing during this year.
- Competition for the most successful pharma AI companies will increase drastically.

Intensive Competition — 2020-2021

- Pretty much all big players in pharma industry are concerned with AI adoption, the tech has become a strategic priority, among other things.

Platform-based Drug Design — 2022-2023

- Leading players of the pharmaceutical industry will be moving towards "platform-based drug design".
- Emergence of comprehensive R&D and business infrastructure that enables end-to-end AI-driven drug development.

Big Pharma’s Focus on AI

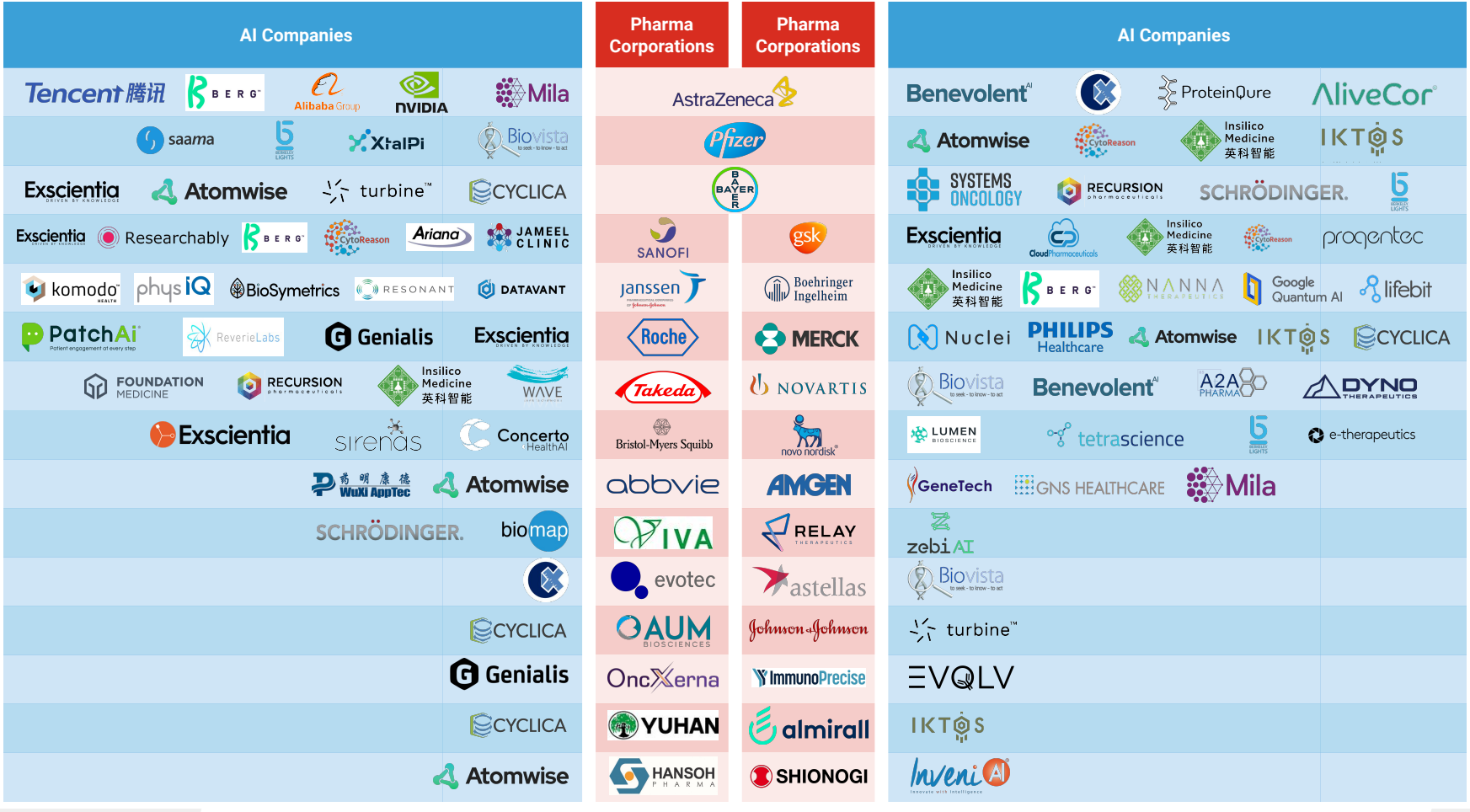


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AI and Pharma Collaborations in 2021

JAN	Merck and Philips partner to advance personalized fertility treatment through remote patient monitoring, cloud-based platform services and mobile, AI-enabled ultrasound diagnostics to support improved access to care and better outcomes in fertility treatment.
FEB	Roche Italia has joined forces with PatchAi to launch a virtual platform for cancer patients.
MAR	Pfizer's small-molecule programs will apply Iktos' AI-driven de novo design software.
APR	AstraZeneca is teamed up with NVIDIA and the University of Florida on new artificial intelligence research projects aimed at boosting drug discovery and patient care.
	Ariana Pharma, a spin-off of the Institut Pasteur specializing in the development of drugs based on artificial intelligence (AI), announced on April 29, 2021 a collaboration with Sanofi.
JUN	GlaxoSmithKline (GSK) announced an 18-month collaborative research agreement with Progentec, a leader in diagnostic and digital technologies for the proactive management of autoimmune diseases, to evaluate novel measurement and management tools for systemic lupus erythematosus.
	Insilico Medicine entered into a collaboration with Teva Branded Pharmaceutical Products R&D, Inc. to utilize Insilico's generative machine learning technology and proprietary PandaOmics Drug Discovery Platform.
JUL	Sosei Heptares and InveniAI Enter a Multi-target AI-powered and GPCR-focused Drug Discovery Collaboration.

Selected Pharma AI Deals Structure until 2021



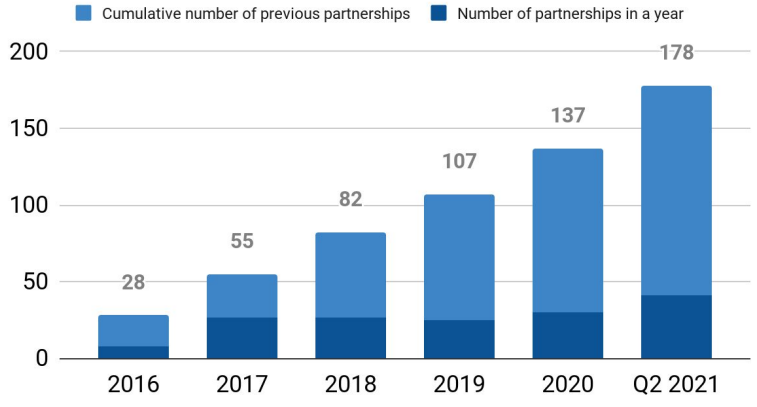
A Growing Number of Collaborations Involving AI for Drug Discovery

Summarizing industry observations over the last five years, we can observe a fundamental shift in perception of top executives at leading pharmaceutical organizations about the need of advanced AI technologies. Since 2015, there has been an obvious shift in the perception from skepticism and cuasious interest, all the way to a realization of a strategic role AI has to play in the emerging “data-centric” model of innovation. This change in perception was underpinned by a number of factors:

- a wave of proof-of-concept studies and research breakthroughs in a wide range of AI application use cases
- a number of commercial successes and successfully reached milestones, involving AI as a central element of research
- substantial advances in democratizing AI technology, where machine learning and deep learning algorithms become available at scale to non-AI experts
- decent increase in the overall understanding of AI “mechanics”, due to increasing efforts in the education and professional development with a focus on AI-driven tools and approaches

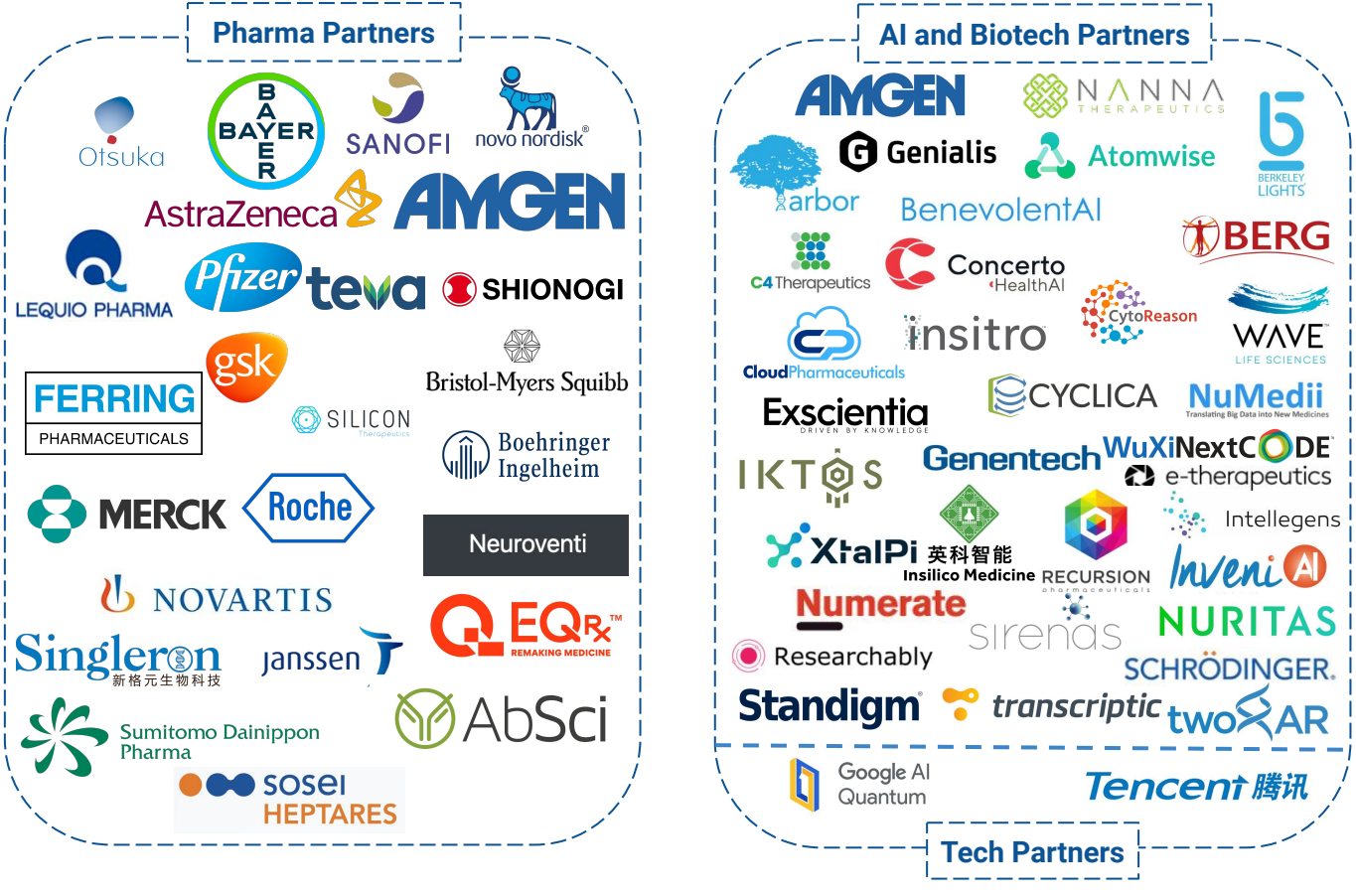
Pharmaceutical companies of all sizes start competing for AI-expertise, talent, and partnerships. In this report we summarize some of the most high-profile such collaborations, involving top-20 pharma giants. Even though, we can see a clear uprising trend in the number of collaborations, focused on AI-drug design, and other aspects of data mining and analytics.

Increasing number of partnerships between Pharma and AI Companies over the last 6 years

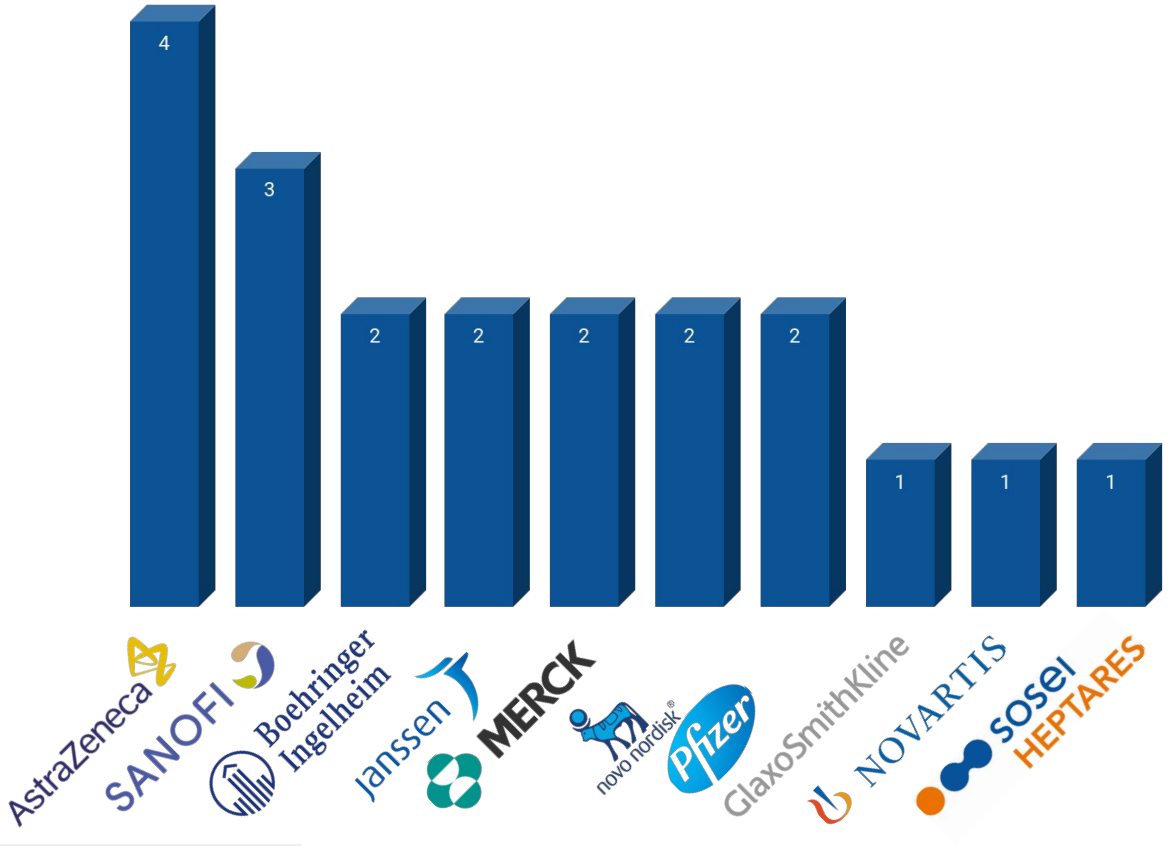


The rising interest of leading pharma and contract research organizations towards AI-driven biotech startups is a major driver for the area to become more attractive for investors, since the industry is becoming well-suited for successful exit strategies in future.

Corporation and AI-companies Participating in the Pharma AI Deals



Top-10 Leading Pharma Corporations by the Number of Pharma AI Deals in 2021



The leading Pharma players by the amount of major industry partnerships are **AstraZeneca** and **Sanofi.**

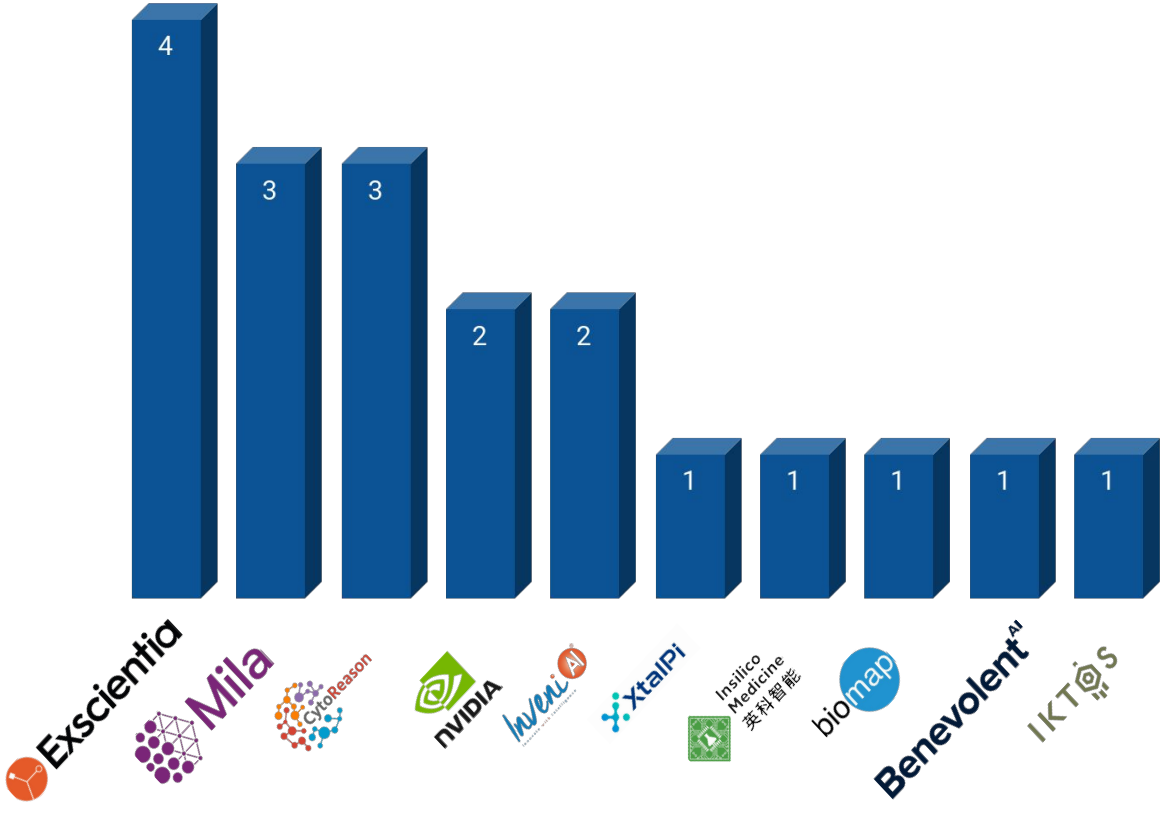
Implications

These companies demonstrate increasing commitment to probing the grounds in the AI space — by investing into internal programs, as well as partnering with external AI vendors to pilot programs in drug discovery and other research areas.

The most common type of deals are **true partnerships** and **saving the costs deals**.

The leading big pharma brands are increasingly open to partnerships with AI startups and corporations to get competitive edge, and mitigate **the problem of declining R&D efficiency**.

Top-10 AI and Tech Partners by the Number of Major Pharma AI Deals in 2021



The leading AI players by the amount of major industry partnerships are **Exscientia**, **Mila and CytoReason.**

Implications

The biggest number of AI in Drug Discovery deals was conducted by **Exscientia**.

The company engages in **small molecule drug discovery, selective single target molecules, bispecific small molecules, and phenotypic drug design.**

All of the deals concluded with this company were categorized as the ones aiming at **saving costs and increasing operational efficiency** due to the character of the services provided.

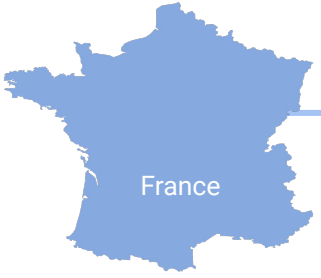
AI in Pharma Publicly Traded Companies



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AI in Pharma Publicly Traded Companies

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Nord-Pas-de-Calais

GENFIT (GNFT)
Loos, Nord-Pas-de-Calais, France

London

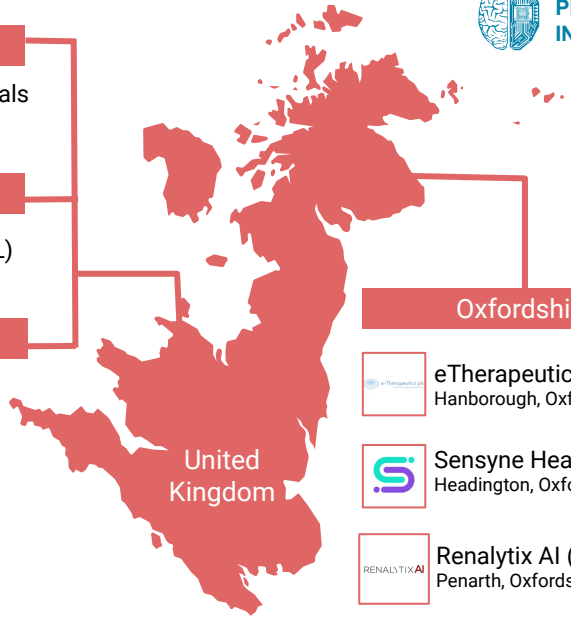
Cotinga Pharmaceuticals (COTQF)
London, England, UK

Manchester

C4X discovery (C4XD.L)
Manchester, Manchester, UK

Glasgow

DeepMatter Group (DMTR.L)
Glasgow, Glasgow City, UK



Oxfordshire

eTherapeutics (ETX.L)
Hanborough, Oxfordshire, UK

Sensyne Health (SENS.L)
Headington, Oxfordshire, UK

Renalytix AI (RENX)
Penarth, Oxfordshire, UK

Connecticut

BioXcel Therapeutics (BX2)
Branford, Connecticut, US

Massachusetts

Relay Therapeutics (RLAY)
Cambridge, Massachusetts, US

ITeos Therapeutics (ITOS)
Cambridge, Massachusetts, US

Colorado

Biodesix (BDSX)
Broomfield, Colorado, US

Evolutionary Genomics (FNAM)
Lafayette, Colorado, US



New York

Schrödinger (SDGR)
New York, New York, US

Texas & Utah

Lantern Pharma (LTRN)
Dallas, Texas, US

Recursion Pharmaceuticals (RXRX)
Salt Lake City, Utah, US

California

Alector (ALEC)
San Francisco, California, US

Berkeley Lights (BLI)
Emeryville, California, US

Biomea Fusion (BMEA)
Redwood City, California, US

Gritstone Oncology (GRTS)
Emeryville, California, US

IDEAYA Biosciences (IDYA)
San Francisco, California, US

Sangamo Therapeutics (SGMO)
Richmond, California, US

Hong-Kong

Regent Pacific Group
Hong-Kong

Acquired

Deep Longevity
Acquired by $4M



AI in Pharma Publicly Traded Companies



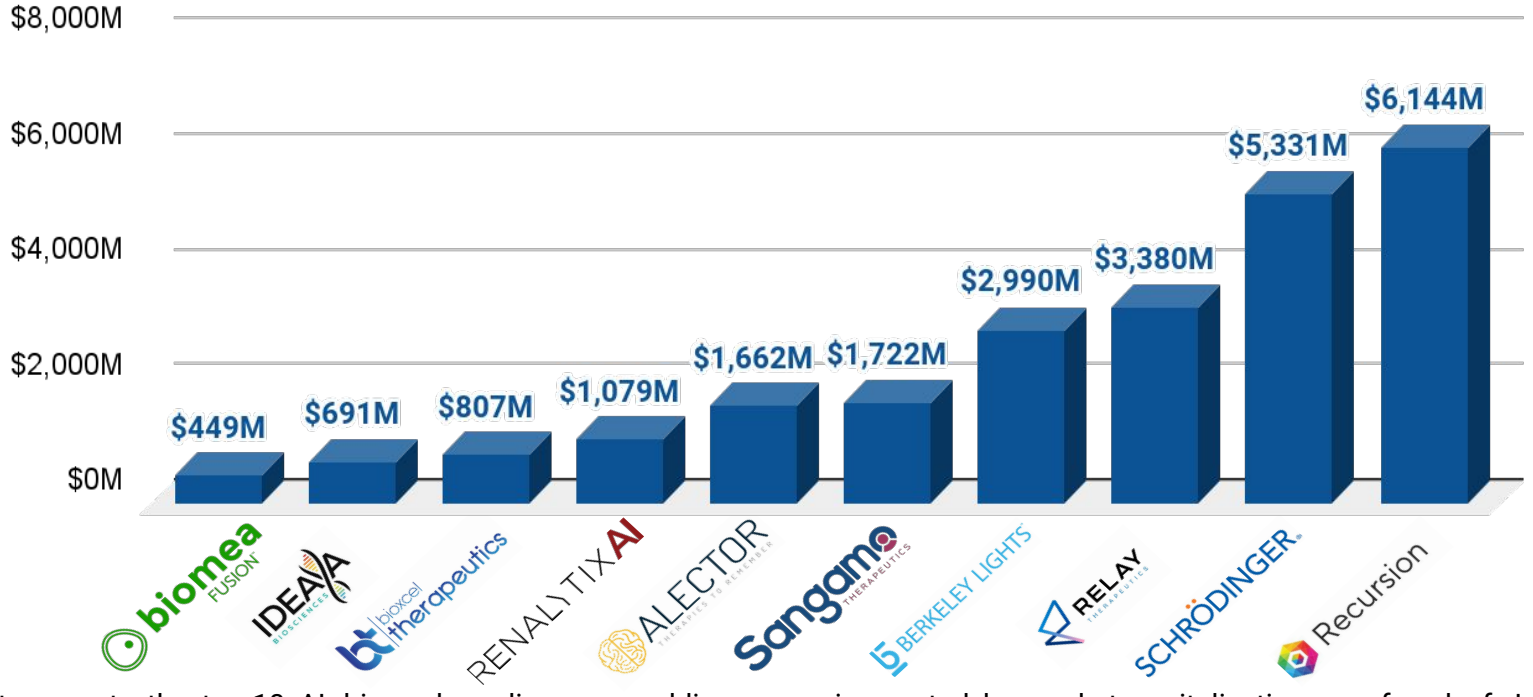
Despite the crisis, publicly traded companies present rapid growth reaching **$27.07B** of cumulative capitalization as of June, 30 2021. **Three** companies from our list have **announced closing of IPO** during Q1-Q2 2021: Evaxion Biotech, Biomea Fusion and Recursion Pharmaceuticals.

The largest companies by market capitalization are Recursion Pharmaceuticals, Schrödinger and Relay Therapeutics.

There was a significant decline of stock prices during Q1 2021. The reason is that established companies with products on the market generating sales receive proper valuation from investors. At the same time, clinical-stage biotech companies are more vulnerable in terms of stock volatility.

Technological publicly traded AI in pharma companies are similar to other companies in the sector, which means that their market capitalization growth can be an approximation of the dynamics of the whole sector.

Top-10 AI-Driven Publicly Traded Pharma Companies by Market Capitalization in 2021



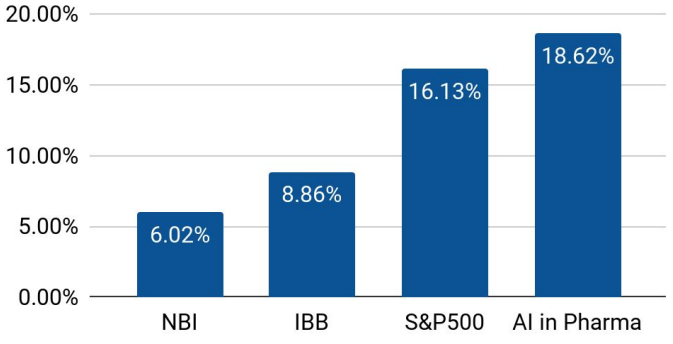
The chart presents the top-10 AI-driven drug discovery public companies sorted by market capitalization as of end of June 2021. Recursion Pharmaceuticals is the leader of the ranking, the company has closed IPO in April 2021 after reaching a deal with Bayer AG in September 2020 for implementation of AI for drug development in area of lung fibrosis and other fibrotic diseases. Schrödinger remains to be among leaders being one of the top-performing life sciences technology companies, with its stock almost quadrupling during the period. Another leader of this graph, Relay Therapeutics, also announced the closing of the IPO in 2021 and raised $400M. The company's investment aggregation performance is remarkable.

AI in Pharma Market Capitalization

AI in pharma corporations market capitalization growth outperforms such market benchmarks as S&P 500 index, as well as general biotech industry indices (represented by IBB and NBI), although AI in pharma stock market segment is more volatile (as measured by standard deviation).

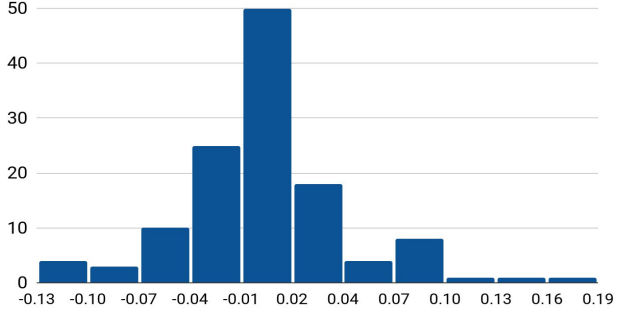
Clinical trials and regulatory decisions can make or break a company's value. There is a number of examples when investors of biotech stocks could get handsome gains followed by scientific breakthroughs.
Interestingly, the distribution of the returns of the AI in the pharma stock market segment is right-skewed. It means that rare extraordinary positive events play a large role in the dynamics of the market capitalization of the segment, which can be described as the presence of "anti-black swans".

Market capitalization growth during Q1-Q2 2021



Index	Correlation with AI in Pharma Market	Average Daily Return in 2021	Average Daily Volatility in 2021	Skewness	Kurtosis
AI in Pharma	-	0.02	0.04	0.62	.2.54
IBB	0.38	0.0007	0.0147	0.20	1.10
S&P500	-0.01	0.0014	0.0095	-0.68	1.32
NBI	-0.45	0.00069	0.0149	0.22	1.11

AI in pharma stock returns histogram

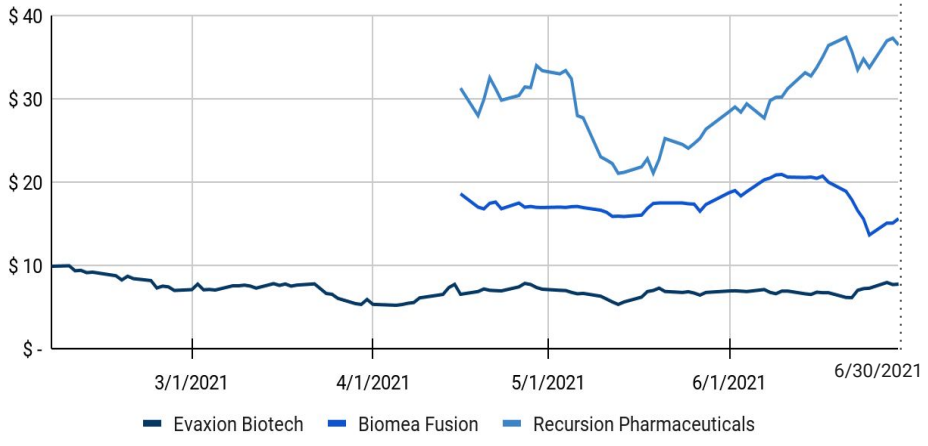


AI in Pharma IPOs in 2021

In 2021 new public companies have successfully closed their IPOs. As for now, these companies are showing volatile but steady growth, although the net income of all corporations remains negative. All IPOs took place in the USA. All companies have beta smaller than 1 (although positive) which means that AI in pharma stock prices move in accordance with the general market, yet the degree of such “movements” is lower .

Major negative market events in 2020-2021 did not affect significantly AI in pharma sector. The industry’s features remain to play a designative role in the overall market volatility.

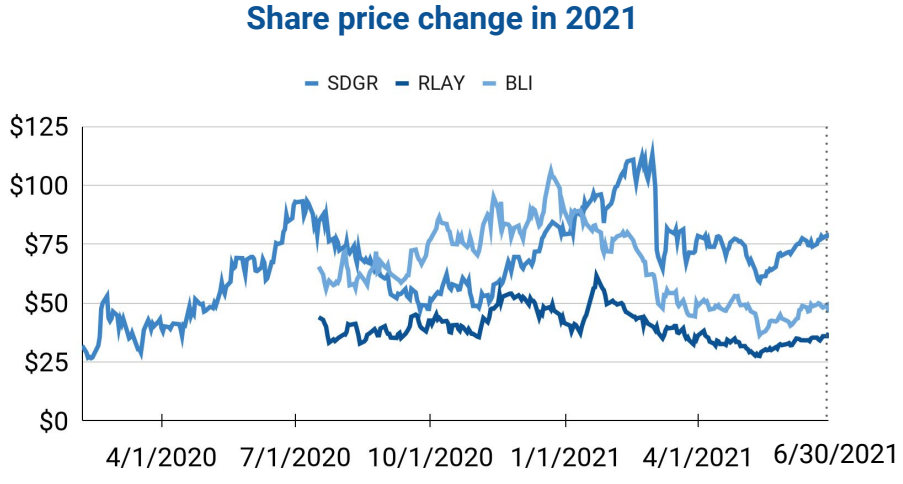
Share price change in 2021



Name	Country	Funding Amount, $M	IPO Date	Capitalization, $M	Valuation at IPO, $M	IPO Share Price, $M	Current Share Price, $M	EV/EBITDA	Net Income, $M
Evaxion Biotech	USA	30	04.02.21	149.82	489	10.00	7.85	-18.34	-16.01
Biomea Fusion	USA	153	15.04.21	451.65	N/A	17.00	15.64	-85	-10.78
Recursion Pharmaceuticals	USA	436.4	16.04.21	6270	2748	18.00	37.30	-91.71	-99.3

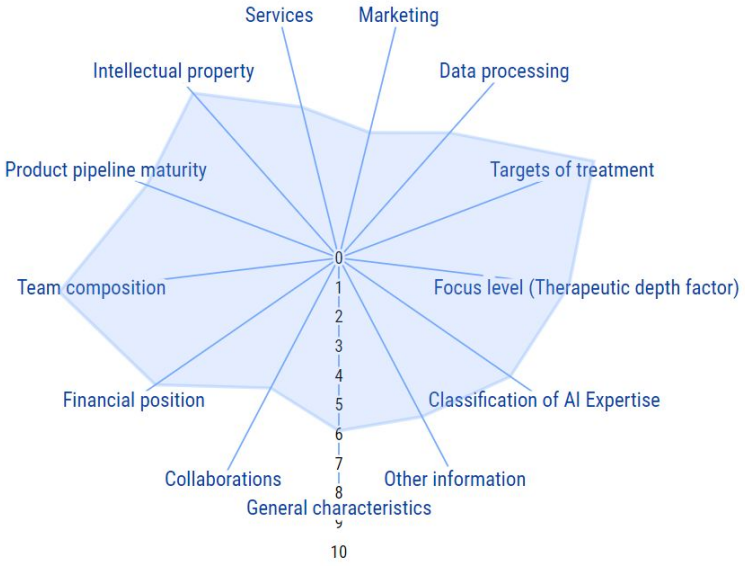
Top AI in Pharma Best-Promising Companies in 2021

Schrödinger, Berkeley Lights and Relay Therapeutics constitute the group of promising companies selected for analysis. They are new to the market (their IPOs closed in 2020). Therefore, their future might change significantly. Moreover, they have decent multi-target pipelines of novel therapeutics to address unmet medical needs. The companies are expected to translate their proprietary insights and technical solutions into effective therapeutics. Currently, the companies have a firm market position and thus receive high expectations from investors.



Name	Country	Funding Amount, $M	IPO Date	Capitalization, $M	Valuation at IPO, $M	IPO Share Price, $M	Current Share Price, $M	EV/EBITDA	Net Income, $M
Schrödinger	USA	562.3	02.05.2020	5348	819	17.00	75.85	-67.90	-10.67
Berkeley Lights	USA	208.5	17.07.2020	3025	1355.2	19.00	45.34	-67.14	-49.53
Relay Therapeutics	USA	520.0	16.07.2020	3480	1736	20.00	37.67	-40.77	-247.5

Evaxion Biotech

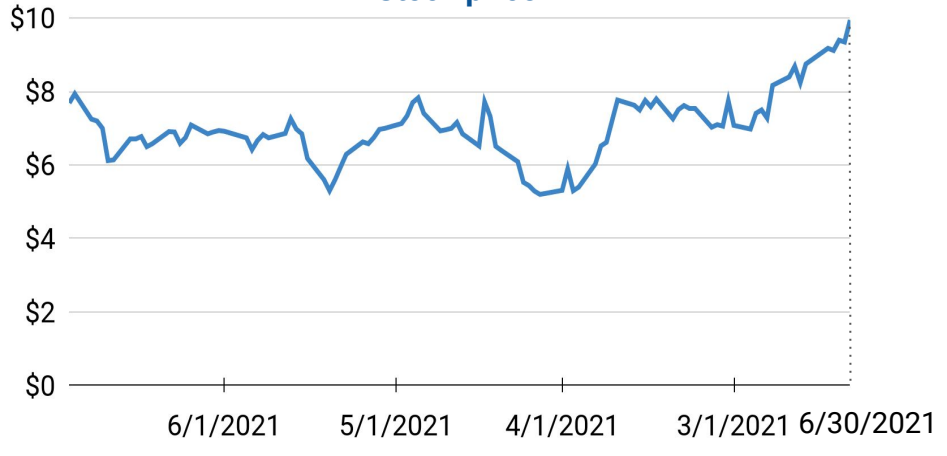


Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $B
EVAX	-0.10%	5.41%	-21.74%	142.646M

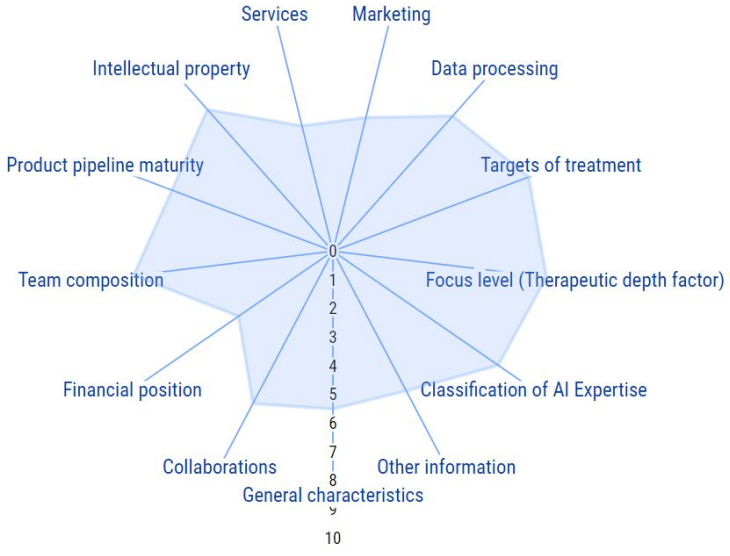
Evaxion Biotech is devoted to the discovery and development of vaccines against cancer and infectious diseases. IT is a clinical-stage AI-immunology™ platform company decoding the human immune system to discover and develop novel immunotherapies to treat cancer and infectious diseases.

EVAX's stock price has stabilized after March decline due to publishing of Q1 2021 Corporate Update Conference Call. The corporate report noted that the Phase 1/2a clinical trials on EVX-01 and EVX-02, the company's lead drug candidates, remain on track, with recruitment ongoing and data readouts expected later this year.

Stock price



Biomea Fusion

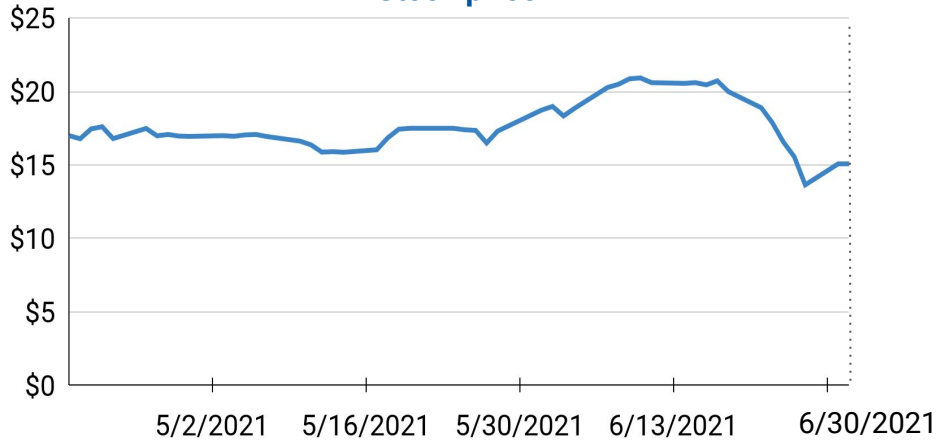


Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $B
BMEA	-0.26%	4.04%	-16.08%	443.026M

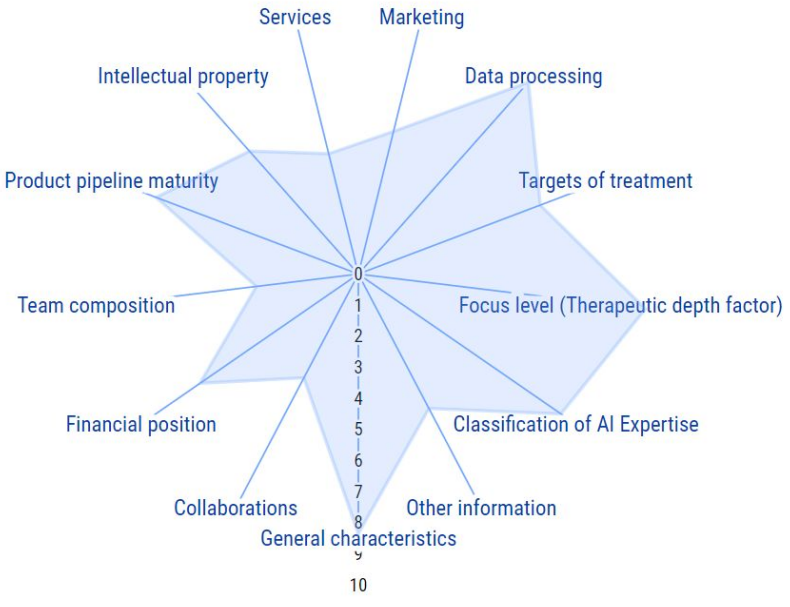
Biomea Fusion is a precision oncology company developing novel small molecules that target aggressive forms of cancer. Biomea Fusion has a development portfolio that targets specific gene alterations which occur in the DNA of patients that translate into key drivers of tumor growth.

Biomea Fusion (BMEA) stock price experienced fall from June 17 to June 25, 2021. However, after appointment of Franco Valle as CFO on June 28, 2021. The stock price started to recover. Mr. Valle is an accomplished financial expert with building the necessary infrastructure to support clinical and operational growth within biotech companies.

Stock price

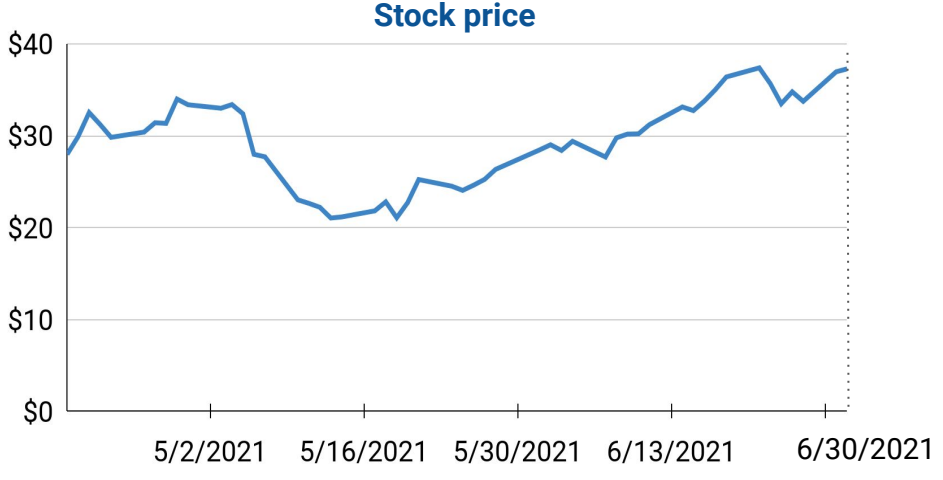


Recursion Pharmaceuticals

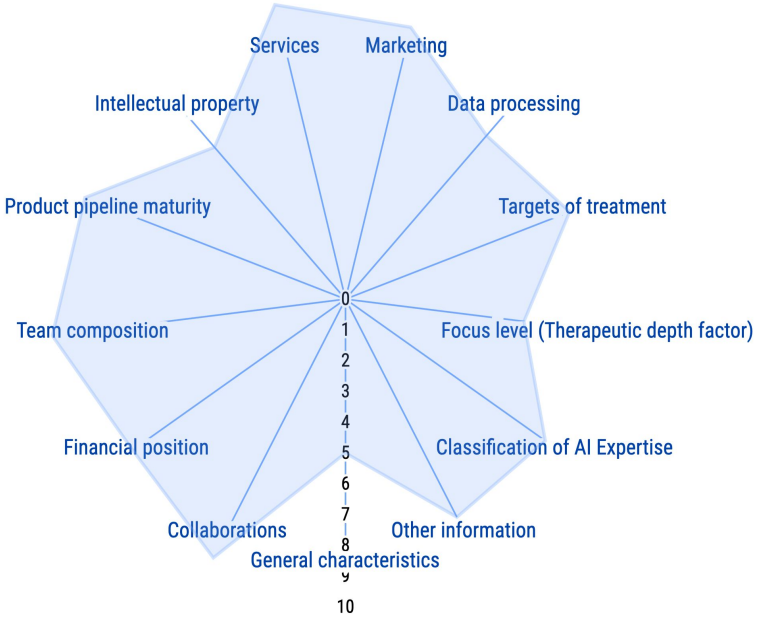


Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $B
RXRX	0.45%	5.66%	16.61%	6.058B

Recursion Pharmaceuticals is is a clinical-stage biotechnology company decoding biology by integrating technological innovations across biology, chemistry, automation, data science, and engineering, with the goal of radically improving the lives of patients and industrializing drug discovery. Central to our mission is the Recursion Operating System, that combines an advanced infrastructure layer to generate what is one of the world's largest and fastest-growing proprietary biological datasets and the Recursion Map.



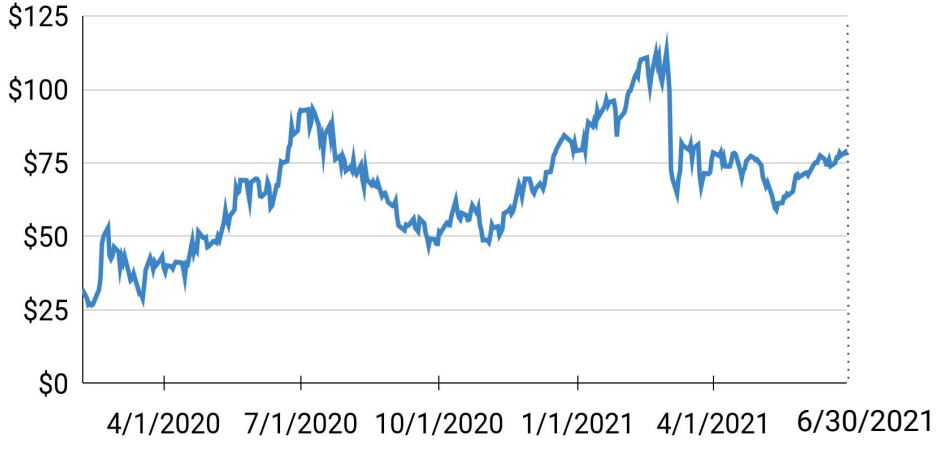
Schrödinger



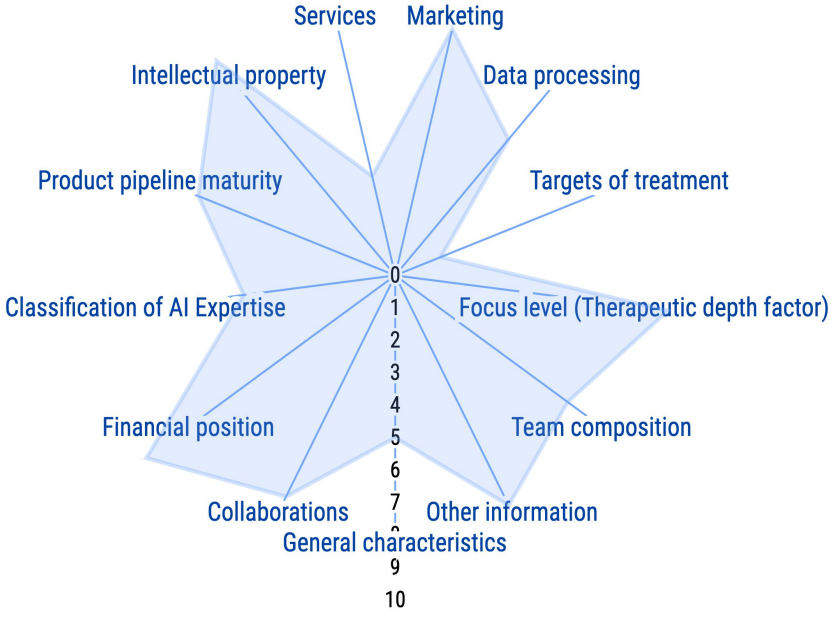
Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $B
SDGR	0.28%	5.18%	178.18%	6.58

Schrödinger's industry-leading computational platform facilitates the research efforts of biopharmaceutical and industrial companies, academic institutions, and government laboratories worldwide. Schrödinger also has wholly-owned and collaborative drug discovery programs in a broad range of therapeutic areas. In addition to its computational platforms Schrödinger provides custom software development, staff training, computer-cluster design, and different types of research-based drug discovery projects.

Stock price



Berkeley Lights



Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $B
BLI	-0.5%	4.27%	-29%	3.025

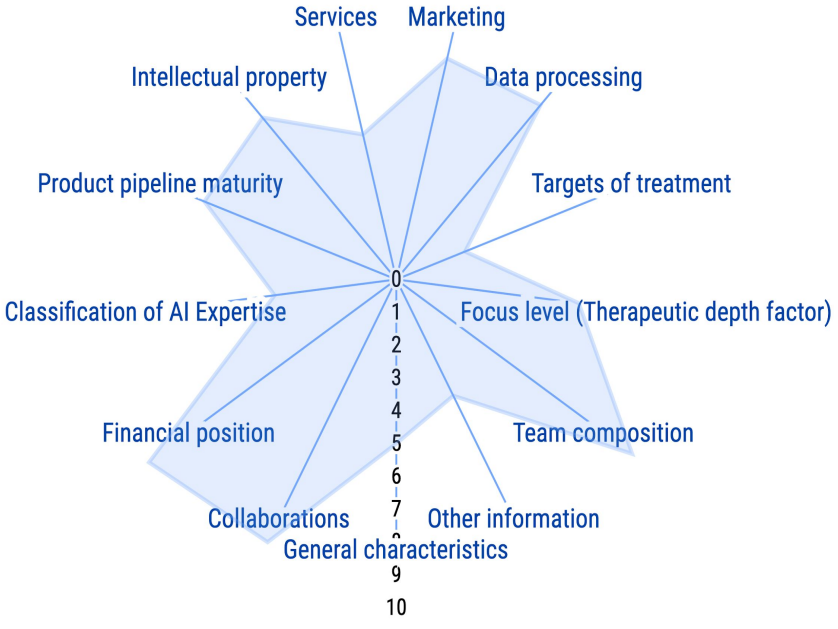
Berkeley Lights is a leading Digital Cell Biology company focused on enabling and accelerating the rapid development and commercialization of biotherapeutics and other cell-based products for the customers. The Berkeley Lights Platform captures deep phenotypic, functional and genotypic information for thousands of single cells in parallel.

The Berkeley Lights Platform accelerates the use of cell-based products. Their proprietary technology – automation, optimized workflows, software, consumables, assay reagents – enables scientists to find the best cells, the first time they look.

Stock price



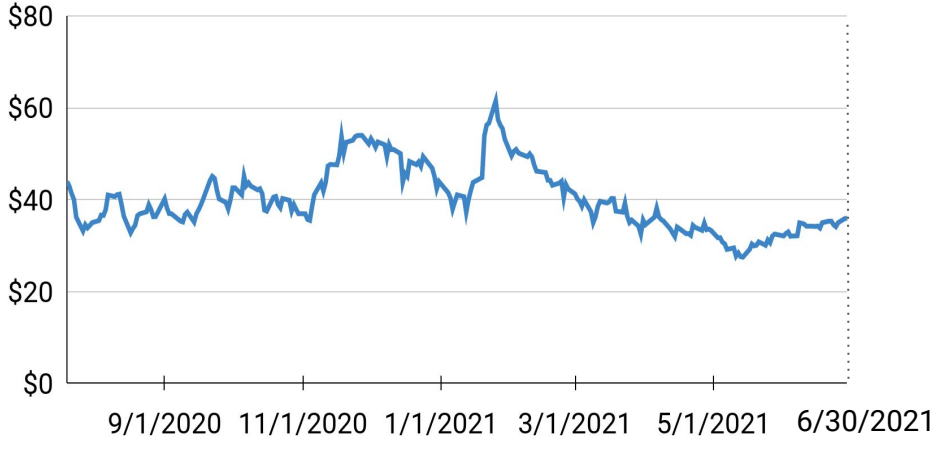
Relay Therapeutics



Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $B
RLAY	0.20%	4.32%	-15%	3.56

Relay Therapeutics is a company focused on precision oncology and rare genetic diseases. Their proprietary Dynamo platform puts protein motion, at the heart of the drug discovery process. It uses advanced machine learning to identify potential novel target binding sites and to predict and design potentially the most effective molecules.

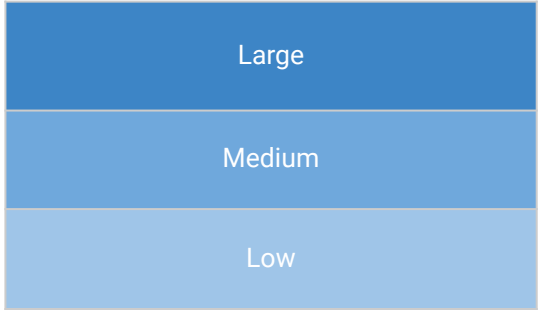
Stock price



AI in Pharma Corporations Financials

Company	Capitalization, $M	Mean Daily Return	Volatility of Daily Returns	IBB Beta	S&P 500 Beta	Total Funding Amount, $M	Operating Margin	EV/EBITDA	Net Income, $M
Gritstone Oncology	277.47	-0.17%	5.78%	0.79	0.75	341.00	-168.24%	-2.05	-94.43
Lantern Pharma	118.13	0.04%	5.02%	0.59	0.30	8.70	0.00%	-25.35	-2.45
Alector	2,810.00	0.17%	5.65%	0.61	0.23	194.50	-11.32%	-12.51	-202.38
Relay Therapeutics	3,560.70	0.10%	6.43%	0.95	1.55	520.00	0.00%	-26.25	-111.60
Schrödinger	6,223.83	0.28%	5.18%	0.34	0.04	562.30	-0.52%	-107.91	-20.09
Sensyne Health	259.10	0.25%	6.79%	0.57	0.19	37.48	-10.26%	-6.63	-21.84
Berkeley Lights	5,648.00	0.25%	4.79%	0.69	0.17	208.50	-68.42%	-225.63	-32.92

AI in Pharma corporations tend to be more volatile than average publicly traded company, although it is compensated by higher returns. For most of the corporations, daily returns are positive and abnormal compared to the market. More volatile stocks are usually characterized by higher betas (both calculated for IBB index and for S&P 500). AI in Pharma segment is definitely a segment of growth stocks with the investors focused on the prospects of the companies rather than on the dividends.



AI in Pharma Corporations Financials

Company	Capitalization, $M	Mean Daily Return	Volatility of Daily Returns	IBB Beta	S&P 500 Beta	Total Funding Amount, $M	Operating Margin	EV/EBITDA	Net Income, $M
Biodesix	592.13	0.90%	7.73%	0.03	-0.27	188.80	-27.77%	-25.84	-33.34
C4X discovery	74.69	0.46%	34.51%	0.92	0.47	6.81	0.00%	-6.53	-7.44
Cotinga Pharmaceuticals	6.64	0.69%	5.31%	-0.04	-0.03	4.20	0.00%	-0.44	-2.54
DeepMatter Group	28.28	-0.01%	5.75%	0.10	0.09	0.00	-216.66%	-8.02	-2.53
eTherapeutics	108.39	0.68%	3.87%	1.10	0.97	66.80	-13.36%	-18.31	-3.41
GenFit	212.20	-0.56%	2.90%	0.22	0.19	95.70	0.00%	-2.71	-65.14
Biomea Fusion	443.03	-0.26%	4.04%	0.00	-0.06	56.00	0.00%	-85.00	-10.80

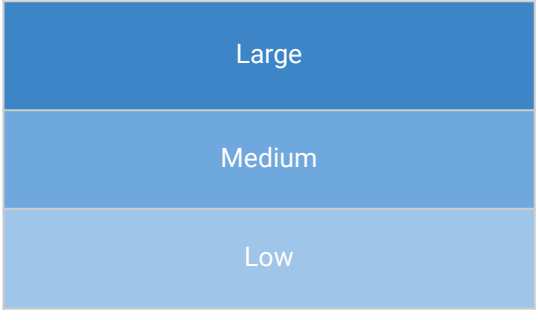
Market capitalization of some AI in Pharma corporations (such as Schrödinger) exceeds **$6B** whereas other companies are priced in the range of dozens of millions of dollars - the difference in the valuation is immense. There is no strong correlation between operating margin or net income and market capitalization - the valuation of the corporations still being unprofitable can exceed billion of dollars.
Selling shares to investors allows them to maintain their cash burn ratios on an acceptable levels.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization, $M	Mean Daily Return	Volatility of Daily Returns	IBB Beta	S&P 500 Beta	Total Funding Amount, $M	Operating Margin	EV/EBITDA	Net Income, $M
BioXcel Therapeutics	777.00	-0.10%	4.78%	-0.01	0.01	0.00	0.00%	-5.60	-93.60
Evolutionary Genomics	7.35	0.32%	8.82%	-0.01	-0.01	1.50	0.00%	-5.77	-2.27
IDEAYA Biosciences	725.91	0.17%	4.11%	0.01	0.02	140.00	-1.19	-14.06	-31.47
ITeos Therapeutics	887.08	0.12%	5.07%	0.01	-0.01	224.30	0.00	-10.33	-50.39
Recursion Pharmaceuticals	6,177.00	0.46%	5.66%	0.09	0.02	465.30	-14.87%	-91.71	-99.30
Sangamo Therapeutics	1,685.00	0.07%	4.83%	0.01	0.01	93.20	-1.00%	-125.09	-124.02
Renalytix AI	1,044.00	0.30%	4.82%	0.02	-0.07	46.40	-26.13%	-25.35	-27.29
Evaxion Biotech	140.34	-0.25%	5.43%	-0.01	0.01	17.00	0.00	-6.37	-16.01

Market capitalization growth of AI-driven Pharma corporations exceeds that of the entire market and general BioTech Industry indices represented as the S&P 500 index and IBB respectively. The difference is that compared to the general market, the AI-driven pharma market segment is more volatile. The distribution of the returns in the segment of AI-driven pharma companies is right-skewed, which differentiates it from the vast majority of stock indices and segments.



Top Publicly Traded Companies Related to AI-Pharma



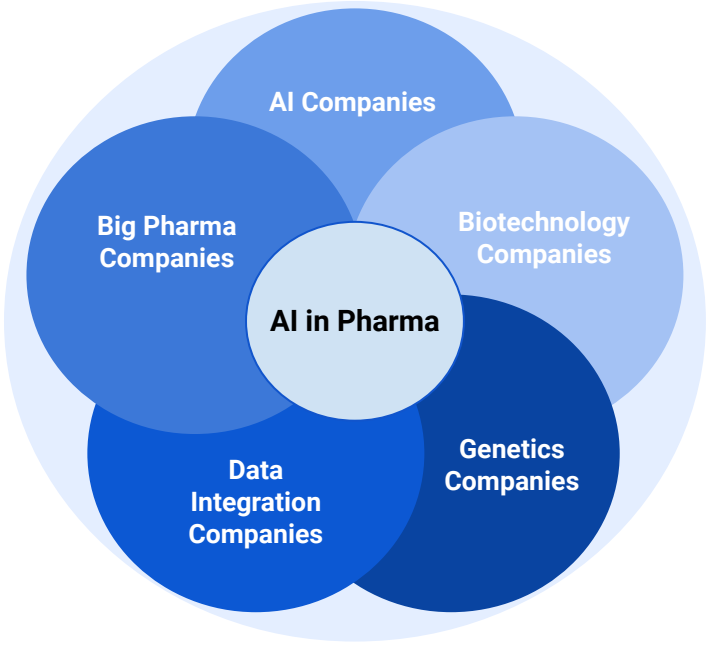
DEEP
PHARMA
INTELLIGENCE

Companies Related to AI-Pharma

AI in pharma sector is an integral part of the contemporary pharmaceutical industry. AI-Pharma sector, defined broadly, is not limited to AI companies, but includes also pharma, tech, chemistry corporations, and CROs that are engaged in collaborations with AI startups, including but not limited to: Mergers & Acquisitions, scientific researches, partnerships, and so on. Hence the companies chosen are better to be described as AI-related or AI-aiming than AI-based solely.

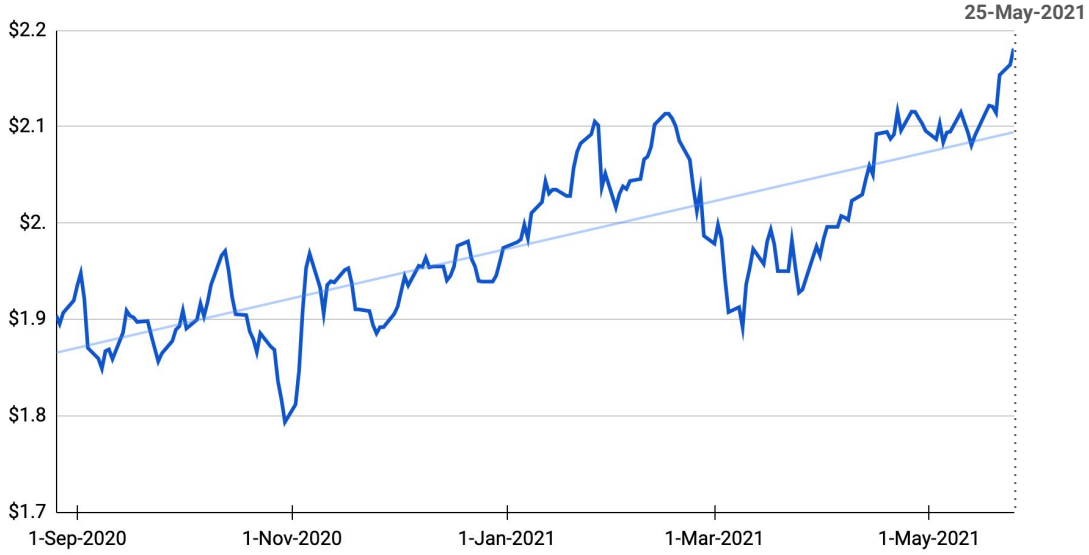
The number of new partnerships between pharma companies and AI companies is ever increasing across the whole industry. On the one hand, AI-focused companies may spend a few years developing all software and tools which pharma companies do not have. On the other hand, large companies, mainly public ones, have solid understanding of their science, extensive experience in the industry and regulatory field, and they are ready to share the risk.

In this chapter we introduce the list of top corporations related to AI-Pharma that were selected based on the analysis of their R&D, financials, and collaborations with the most promising and advanced AI-Pharma startups.



Publicly Traded Companies Related to AI-Pharma

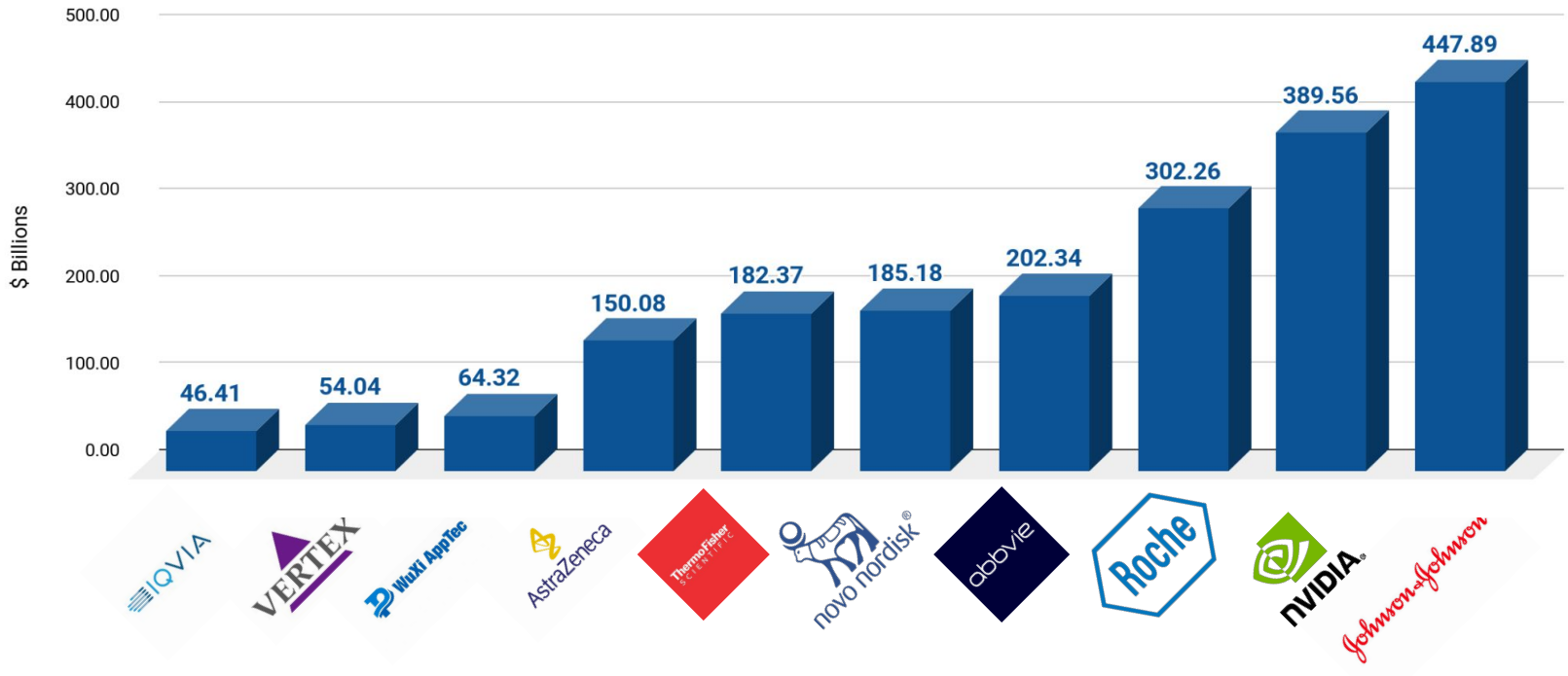
Cumulative Capitalization of Publicly Traded Companies Related to AI-Pharma, 2020-2021, $ Trillion



Driven to some degree by the COVID-19 pandemic, publicly traded companies related to AI-Pharma demonstrated significant growth, **reaching $2.18T** industry capitalization in May 2021. Investor sentiment is being directed towards industries of this nature.

We see significant potential for Artificial Intelligence in the Pharmaceutical Industry. The **expected Compound Annual Growth Rate** for this is market is projected to be **around 40% over the next 3 years**. The Biotechnology Industry is poised to witness a quantum leap soon, mainly because of the impact of Artificial Intelligence on biomedicine R&D. Many transactions are being announced, including Parexel's **acquisition for $8.5B**, that indicates growing awareness of the disruptive potential in this sector for ones having the right means for participation. COVID-19 will continue to push valuations and M&A activity in the sector.

Top 10 Publicly Traded AI-Pharma Related Companies by Market Capitalization in 2021



The chart represents top 10 public companies that ended up in our portfolios according to their market capitalization (as of May of 2021). Johnson and Johnson, Roche Holdings and NVIDIA top our list accounting 52.3% of the capitalization of all companies included. Despite the performance decline that Vertex Pharmaceuticals have had in the past year, it still ended up in our top. On the other hand, almost $5B PPD's growth wasn't enough for the company to propel it in our top-10.

Investment Groups with Publicly Traded Companies Related to AI-Pharma

1. Pharmaceutical Product Development
2. ICON
3. Charles River Laboratories
4. PRA Health Sciences
5. IQVIA
6. WuXi Apptech
7. Syngene International
8. Agilent
9. Thermo Fisher Scientific
10. Abbvie
11. Johnson and Johnson
12. Roche Holding
13. Novo Nordisk
14. Astrazeneca
15. NVIDIA
16. Almirall
17. Evotec
18. Nuance Communications
19. Ipsen
20. Renalytix AI
21. JOINN Laboratories
22. C4X Discovery Holdings
23. Vertex Pharmaceuticals
24. Schrödinger
25. Berkeley Lights
26. Relay Therapeutics
27. BioXcel Therapeutics
28. Lantern Pharma
29. DeepMatter Group

After a process of fundamental and technical analysis, DPI analytics created a list of 29 companies that are of great investment interest. These companies could be structured in thematic investment groups, based on the products they provide, their overall history, market share and other parameters. A brief overview of some companies, as well as the rationale for their inclusion in our list, could be found on the following pages.



Top Publicly Traded Companies Related to AI-Pharma

Roche Holding (RHHBY) — Roche Holding AG offers pharmaceutical products for treating anemia, cancer, cardiovascular, central nervous system, dermatology, hepatitis B and C, HIV/AIDS, inflammatory, autoimmune and other diseases. The company widely implements data-driven solutions, for example Roche has acquired Viewics, Inc. Viewics focuses on business analytics for laboratories, taking data from a variety of sources and extracting it to make faster data-driven decisions in operating processes in the labs.

Novo Nordisk (NVO) — Novo Nordisk is a healthcare company, engages in the research, development, manufacture, and marketing of pharmaceutical products worldwide. It operates in two segments, Diabetes and Obesity care, and Biopharm. Novo Nordisk actively implements different AI in Pharma solutions, its foundation awards DKK 138 million under its new data science and artificial intelligence initiative.

Astrazeneca (AZN) — Astrazeneca discovers, develops, manufactures, and commercializes prescription medicines in the areas of oncology, cardiovascular, renal and metabolism, respiratory, infection, neuroscience, and gastroenterology worldwide. Astrazeneca uses advancing genomics research with AI and big data, AI is already being embedded across companies R&D both for research and experiment optimization.

AbbVie (ABBV) — AbbVie is one of the so-called Big Pharma companies. The company uses AI not only for direct development but also for its own enhancement: Abbelfish Machine Translation and AbbVie Search are built for accelerating and scaling the work of the company' researchers, reducing the time it takes to discover and deliver transformative medicines and therapies for patients.

Top Publicly Traded Companies Related to AI-Pharma

Berkeley Lights (BLI) — Berkeley Lights is a leading Digital Cell Biology company focused on enabling and accelerating the rapid development and commercialization of biotherapeutics and other cell-based products for the customers. Besides 2 unique optofluidics system, Berkeley Lights is known for antibody discovery and cell lines development that definitely requires the usage of AI-powered algorithms and technical solutions.

DeepMatter Group (DMTR) — DeepMatter Group Plc operates as a big data and analysis company. It offers DigitalGlassware platform to deliver applications resulting in optimized chemicals, materials, and formulations in various areas, such as pharmaceutical research, fine chemicals, scientific publications, and teaching. The company develops and commercialises cheminformatics software to handle, store, and retrieve chemical structures and reactions for application in pharma; and tools for the production of synthesis planning and reaction prediction solutions, as well as engages in the automatic extraction of scientific information from text and images.

Pharmaceutical Product Development (PPD) — Pharmaceutical Product Development is another big CRO company. PPD ended up in our portfolio for a great reason, collaborating with Happy Life Tech for AI support, the company aims to create Data Science-driven Clinical Research Solutions in China to enhance global drug development.

Charles River Laboratories (CRL) — Charles River Laboratories is a well-known Contract Research Organization (CRO) specializing in research and drug development. CRL uses the AtomNet™ platform, which is a deep convolutional neural network created for structure-based drug discovery. The company also works with the Valence Discovery Platform for Hit-to-Lead acceleration and optimization and provides all research services considering these platforms.

Top Publicly Traded Companies Related to AI-Pharma

Agilent (A) — Agilent is one of the biggest Biotech companies providing technical solutions for the Pharmaceutical industry. Lots of company' technical solutions already have built-in or support different type of AI algorithms. Also, Agilent and Visiopharm co-promote advanced digital Precision Pathology Solutions.

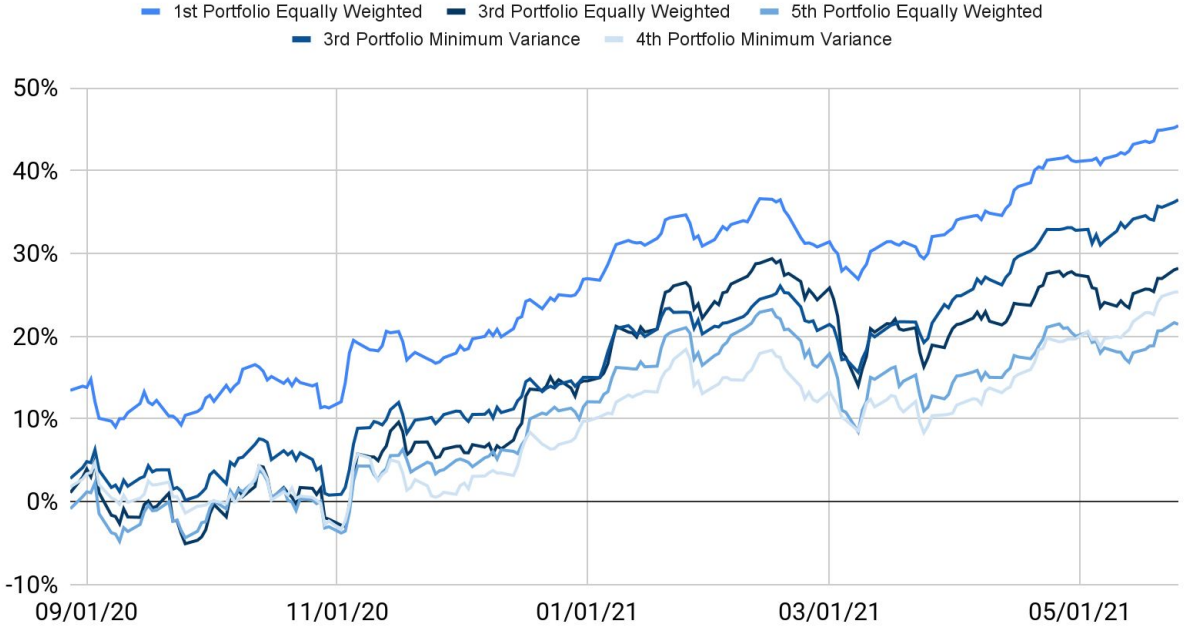
Thermo Fisher Scientific (TMO) — Thermo Fisher is another, even bigger, Biotech company that is specializing in technical solutions, providing also a wide range of other services. "The connected Lab" is a good example of AI-enhanced services providing by the company, creating solutions for enhanced in-Lab performance via AI-based info-gathering and analysis. AI-based processing tools are now also available in Thermo Scientific Amira-Avizo Software and PerGeos Software.

Johnson and Johnson (JNJ) — Johnson and Johnson is considered o be among the TOP-3 biggest Pharmaceutical companies in the world, therefore not only implementation but also investing in AI in Pharma is provided by the company. In 2020, J&J announced an investment in Datavant Holdings, which is working to help healthcare organizations unite data across institutions to enhance medical research and patient care. Another JJI partner, Aetion Inc., analyzes electronic medical records, insurance claims, patient registries and lab results to generate healthcare-related decisions.

Almirall (ALM) — Almirall is a leading skin-health focused global pharmaceutical company, that has some recent collaborations with Iktos for the creation of generative modelling AI technology for quick identification of molecules with multiple bioactivity and drug-like criteria.

Overall Performance / Equally Weighted and Minimum Variance Portfolios

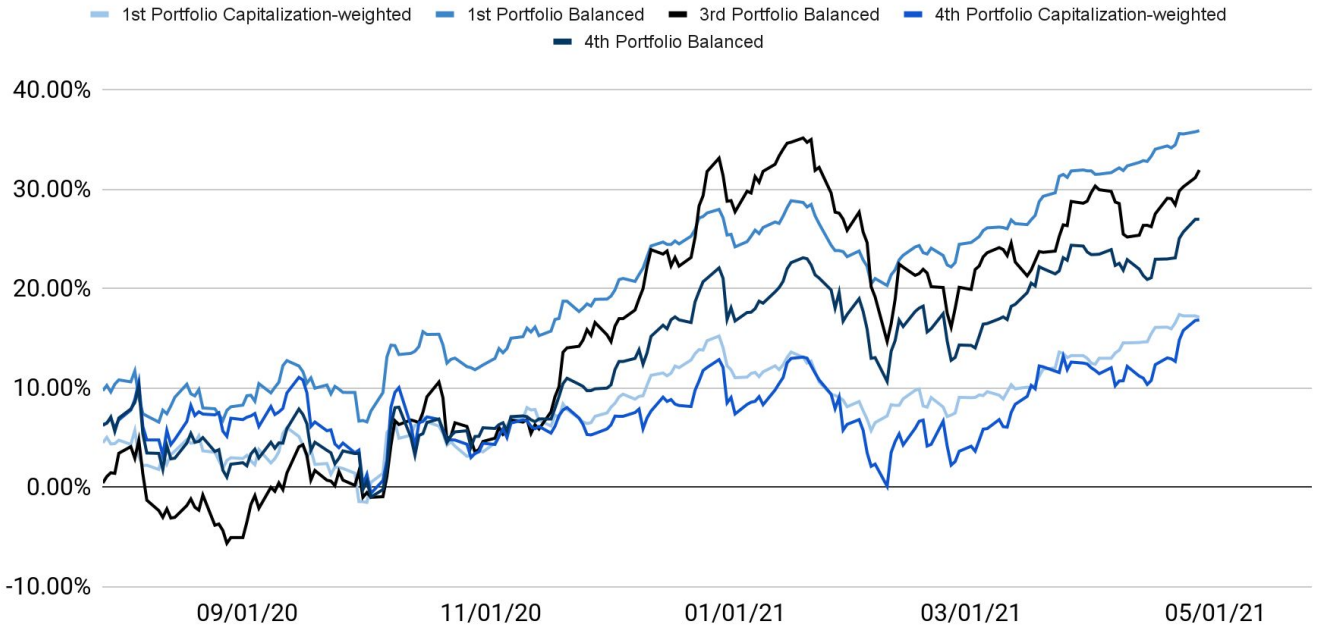
DPI analytics used five different strategies during the creation of portfolios: Equally Weighted, Minimum Variance, Capitalization-weighted, Balanced and Sharpe Ratio-based strategies.



As a result of our analysis, we have decided on 5 different combinations of the companies. Here is the simultaneous performance of the First and Fifth Portfolios with equal weights, as well as Third and Fourth Minimum Variance Portfolios adjusted to the first relevant date of the last company launched an IPO.

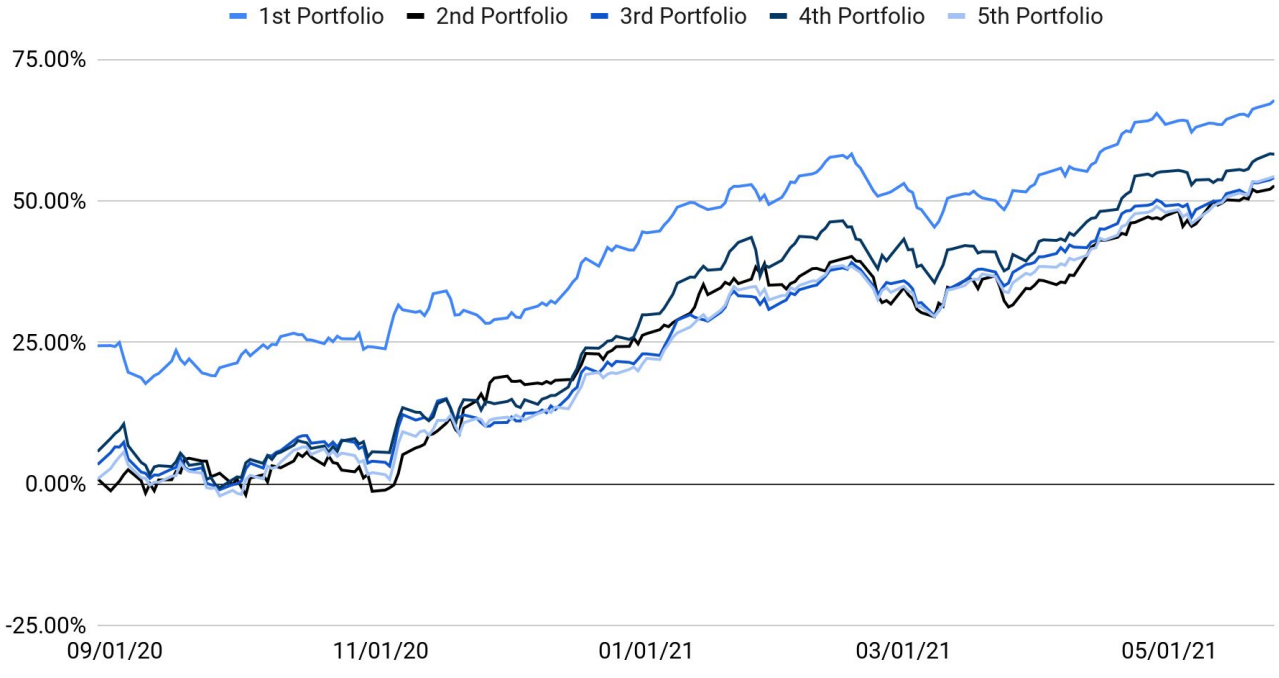
Overall Performance / Capitalization-weighted and Balanced Portfolios

On the one hand, here is the simultaneous performance of the First and Fourth Capitalization-weighted Portfolios. On the other hand, there are Balanced Portfolios which outperform the aforementioned Capitalization-based strategies. Portfolios are adjusted to the first relevant date of the last company launched an IPO:



Overall Performance / Sharpe Ratio-based Strategies

Here is the simultaneous performance of the Sharpe ratio-based investment strategies, adjusted to the first relevant date of the last company launched an IPO:



Overall Performance / Performance matrix

This is a brief performance matrix of all our portfolios with different investment strategies. The rightmost column indicates the period tracked for a given portfolio and strategy:

Return | SD	Equally Weighted	Market Cap	Minimum Variance	Sharpe	Balanced	Period
1st Portfolio	45.42% | 0.92%	17.09% | 0.87%	25.79% | 0.76%	67.72% | 1.15%	35.87% | 0.85%	12 Months
2nd Portfolio	8.61% | 1.64%	-12.70% | 1.8%	26.36% | 1.15%	52.63% | 1.34%	5.66% | 1.63%	9 Months
3rd Portfolio	28.20% | 1.32%	37.28% | 1.76%	36.48% | 0.99%	54.10% | 1.13%	31.91% | 1.39%	10 Months
4th Portfolio	35.31% | 1.33%	16.82% | 1.28%	25.36% | 1.00%	58.21% | 1.32%	26.96% | 1.27%	10 Months
5th Portfolio	21.44% | 1.15%	12.74% | 1.05%	20.55% | 0.77%	54.28% | 1.09%	17.25% | 1.07%	9 Months

Conclusions

1. The **AI in Pharma sector** have been experienced **significant growth** over the past year. This could be clearly seen by the overall dynamics of the chosen companies.

2. Despite common misconception, **AI in Pharma includes not only SaaS-specialized companies**, Big Pharma, as well as top-CRO companies should be included in this list among other newcomers.

3. Due to the market's significant growth, **all portfolios shows remarkable results, indicating valid investment opportunities**. At the same time such opportunities, i.e. possibilities, **shouldn't be replaced with certainty**.

4. There are plenty of companies that should be considered as promising ones, which **shows both market dynamics and investment expediency**.

5. Best performance is shown by **Sharpe ratio-based portfolios**, our **Balanced portfolios have outperformed** all classical **Capitalization-based portfolios** showing higher investment expediency.

6. The overall performance of different investment waging strategies shows that **all types of investors**, both risk averse and risk-seeking, **will find enough opportunities for themselves**.

Deep Pharma Intelligence: Upcoming Projects and Analytical Tools



[Deep Pharma Publicly Traded Companies Big Data Analytics Dashboard]

AI for Advanced R&D: Applications and Use Cases



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Notable AI Breakthroughs

March, 2018

IBM Watson released a cognitive computing platform for Clinical trial matching that has shown significant improvement in patient enrollment rate at **Mayo Clinic**. Since its implementation in the Mayo clinic in 2016, the platform demonstrated an 80% increase in enrollment in clinical trials for breast cancer. The platform also significantly reduced the time to match a clinical trial to one patient.

October, 2018

Healx has prepared a rare disease drug for a Phase 2a clinical trial in 15 months. Healx has demonstrated the power of combining domain expertise, deep learning, and proprietary data. As a result, the company implemented a scalable platform for drug discovery — Healnet. The drug was created for the of Fragile X syndrome. It tooks 15 month to conduct lead discovery, preclinical validation, and submitting a publication.

December, 2018

DeepMind built AlphaFold platform to predict 3D protein structure that outperformed all other algorithms. AlphaFold won the CASP13 competition. AlphaFold was able to most accurately predict the shape for 25 of the 43 proteins from scratch without using previously solved proteins as templates. AlphaFold uses two methods based on deep neural networks: one is trained to predict the distances between pairs of certain amino acids, and the other estimates the possible angles of chemical bonds between them.

January, 2019

Recursion Pharmaceuticals has announced progress in its collaboration with **Takeda.** Recursion has evaluated Takeda's preclinical and clinical molecules in over 60 indications in less than 18 month. New drug candidates were identified for 15 indications. Recursion's AI-enabled drug discovery platform combines massive biological data generation at scale with state-of-the-art machine learning that can draw meaning from millions of microscopy images generated in Recursion's laboratory with Takeda's compounds.

Top AI Breakthroughs

September, 2019

1. Insilico Medicine has published a research paper about the first in vivo active drug candidate developed from scratch (de-novo) using GENTRL system. GENTRL system is a modular drug design platform based on generative adversarial networks (GANs) and other machine learning methods. A new candidate has been developed staggeringly quickly: in 46 days, including target selection.

2. Deep Genomics created DG12P1 drug using an AI-augmented drug design. It is an antisense oligonucleotide therapy designed via their platform **AI Workbench** to treat rare Wilson disease, leading to copper accumulation in the liver, brain and other vital organs. The discovery took under 18 month from the concept to an actual clinical trials-ready drug candidate, which is way faster compared to classical approaches. Deed Genomics platform screened over 2,400 diseases and over 100,000 pathogenic mutations. It predicted and confirmed the precise disease-causing mechanism of the mutation Met645Arg. Then it identified 12 lead candidate molecules.

January, 2020

1. Mendel Recruit proprietary platform could increase patient enrollment for clinical trials by 24-50%. Mendel Recruit platform was applied retroactively to two completed oncology clinical studies and one that failed to recruit patients at a clinical trial site. Using the Mendel.ai platform resulted in a 24-50% increase over the standard practice in the number of patients correctly identified as potentially eligible. Mendel applied AI algorithms that combine the recognition of scanned documents with natural language understanding of clinical records and automated clinical reasoning.

2. A new drug candidate, DSP-1181, created using **Exscientia** Centaur Chemist Artificial Intelligence platform began clinical study. The drug was developed together with **Sumitomo Dainippon Pharma** for the treatment of obsessive-compulsive disorder, it was advanced to Phase 1 clinical trials. Less than 12 months was spent to complete the exploratory research phase when it typically takes 4.5 years.

Top AI Breakthroughs

February, 2020

Scientists from **MIT** discovered halicin — a new super powerful antibiotic capable to kill 35 the world's most problematic disease-causing bacteria, including multiresistant strains. In experiments with E. coli, this bacteria didn't develop resistance during 30 days. The model applied was able to screen more than a hundred million chemical compounds in a matter of a day, and is designed to pick out potential antibiotics that kill bacteria using different mechanisms than those of existing drugs.

September, 2020

1. Aladdin has built a platform for the early diagnostics of Alzheimer's disease and COVID-19. The company is building biomedical knowledge graphs — PharmaKG — around age-related disease to reveal mechanisms and potential drugs by uncovering key relationships between disease, genes, chemical compounds and drugs. Disease Diagnosis platform uses AI and multimodal data, including biomarkers, imaging, blood samples, medical records, etc.

2. MELLODDY — the 'Machine Learning Ledger Orchestration for Drug Discovery' group — was created by ten pharma companies to jointly develop ML models without sharing data. MELLODDY leverages the world's largest collection of small molecules with known biochemical or cellular activity to provide more accurate predictive models and improve drug discovery efficiency. MELLODDY is trying to achieve this by creating a flexible, scalable, and secure framework for federated and privacy-preserving machine learning that can train and evaluate predictive models related to drug discovery.

February, 2021

Insilico Medicine achieved industry-first nominating Preclinical Candidate. The company performed all the required human patient cell, tissue, and animal validation experiments to claim a first-in-class preclinical candidate for a novel pan-fibrotic target, currently in preparation for clinical development.

Top AI Breakthroughs

March, 2021

Cyclica launched an AI-based drug discovery platform which achieved over 60% of actionable hits for its pharma clients. Cyclica has partnered with over 100 global pharma and biotech companies and academia across many therapy areas such as respiratory, oncology, neurodegenerative diseases, infectious disease, ophthalmology and rare disease. These partnerships have resulted in 64% of programmes resulting in actionable hits.

May, 2021

1. BioXcel Therapeutics, Inc. a clinical-stage biopharmaceutical company utilizing artificial intelligence approaches to develop transformative medicines in neuroscience and immuno-oncology, announced that the U.S. Food and Drug Administration (“FDA”) has accepted for filing the New Drug Application (“NDA”) for BXCL501, the Company’s proprietary, investigational, orally dissolving thin film formulation of dexmedetomidine, for the acute treatment of agitation associated with schizophrenia and bipolar disorders I and II.

2. Using its AI technology, **Exscientia** designed an Alzheimer’s disease drug candidate which has entered Phase I clinical testing. The AI-designed drug candidate will be assessed for improved antipsychotic effects associated with Alzheimer’s psychosis, in addition to improvements in behavioural and psychological symptoms of dementia including agitation, aggression, anxiety and depression.



Computational Methods Used by the Most Advanced AI Companies



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Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
Ardigen	Bioinformatics, Deep Learning, NLP	Ardigen is a Polish bioinformatics company, part of the Selvita Group. The company is active in the field of laboratory information management systems, biological and clinical data analysis, Big Data integration, as well as custom application development. Through its know-how, experience and products, Ardigen supports the life science and healthcare industries in executing the idea of personalized medicine. Ardigen employs world-class specialists in the field of bioinformatics, biotechnology, mathematics, statistics and computer science.
Atomwise	Machine Learning, Deep Learning (Convolutional neural networks), cheminformatics	AtomNet is the first drug discovery algorithm to use a deep convolutional neural network. It excels at understanding complex concepts as a combination of smaller and smaller pieces of information. AtomNet has been predicting new potential treatments for two years. It has already explored questions in cancer, neurological diseases, antivirals, antiparasitics, and antibiotics.
BenchSci	NLP, Deep Learning, Machine Learning	Decodes open- and closed-access data on reagents such as antibodies and present published figures with actionable insights. It allows researchers to: reduce time, money, and uncertainty in planning experiments.
BenevolentAI	Machine Learning, Deep Learning, symbolic AI, cheminformatics	Evolved from text mining and semantic linking into knowledge graphs. Recent small efforts into DL and computational chemistry mostly for PR.

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
Berg	Machine Learning, Deep Learning, bioinformatics	Analyze data from patient samples in both healthy and diseased states to generate novel biomarkers and therapeutic targets. Allows researchers to: Generate therapeutic targets from biological data in an unbiased way, and implement personalized medicine at scale.
Berkeley Lights	Machine Learning, bioinformatics	Automate selection, manipulation, and analysis of cells. Allows researchers to: Expedite development of cell lines and automate manufacturing of cellular therapeutics.
BioSymetrics	NLP, Deep Learning, Machine Learning	Process raw phenotypic, imaging, drug, and genomic data sets. Allows researchers to: Integrate rapid analytics and machine learning capabilities into existing business processes to improve care, enhance discoveries, gain insight into business, and enable fast data-driven decisions.
Bioz	NLP, Deep Learning, Machine Learning	Bioz has developed a search engine for Life Sciences community using natural language processing and machine learning technology to scan hundreds of millions of pages of complex and unstructured scientific papers on the web. Then it helps summarize the information into usable visualized format.
Euretos	Machine Learning, Deep Learning, bioinformatics	Euretos provides direct access to the cloud based discovery platform via user friendly application. It also allows API Integration of the discovery platform in user's company's IT environment/workflows, as well as Integration of company proprietary data and public data in a secure environment.

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
Exscientia	Machine Learning, Deep Learning, bioinformatics, cheminformatics	The company uses ML for predicting ADME, novelty, synthetic accessibility, pharmacology of molecules. Single and multi-target prediction.
Iktos	Machine Learning, Deep Learning, cheminformatics	Iktos has invented and is developing a technology based on DL for ligand-based de novo drug design, focusing on multi parametric optimization (MPO).
Insilico Medicine	Deep Learning, GANs, GANs + Reinforcement Learning, symbolic AI, Machine Learning, cheminformatics, bioinformatics	Comprehensive DL pipeline. Biology: Signaling pathways, DNNs for target ID and HTS analysis. Chemistry: GANs-RL for novel molecule generation.
Kyndi	NLP, Deep Learning, Machine Learning	Kyndi provides leading artificial intelligence software that can analyze long-form text and find actionable insights in a smarter, faster, and more explainable way.
MedChemica	Machine Learning, cheminformatics	Molecular design and analysis. With over 40 years of drug hunting experience across all major target classes in 6 disease areas both in Lead Generation, Lead Optimisation and method development our goal is to accelerate the progress of our clients programmes.
nference	NLP, Deep Learning	nferX uses state-of-the-art Neural Networks (shallow and deep learning models) for real-time, automated extraction of knowledge from the commercial, scientific, and regulatory body of literature.

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
NuMedii	Big data analytics; Deep Learning, Machine Learning	Discover connections between drugs and diseases at a systems level by analyzing hundreds of millions of raw human, biological, pharmacological, and clinical data points. Allows researchers to: find drug candidates and biomarkers predictive of efficacy for diseases.
Nuritas	Deep Learning, Bioinformatics	Predict the therapeutic potential of food-derived bioactive peptides. Allows researchers to: cost-effectively develop highly targeted treatments for specific diseases from natural food sources.
Peptone	Deep Learning (TensorFlow + Keras base)	World's first protein database specifically for Deep Learning and AI applications with full Keras™ and Tensorflow™ integration.
Phenomic AI	Deep Learning, Reinforcement Learning	Phenomic predicts which cells will survive chemotherapy and identifies compounds that selectively target these resistant cells. It will then develop the compounds and bring them to market. The prediction requires the use of cell imaging technology, which is where the AI comes in.
ProteinQure	Quantum Computing, Reinforcement Learning, Cheminformatics	ProteinQure is combining quantum computing, reinforcement learning, and atomistic simulations to design protein drugs. They can design peptide-based therapeutics and explore protein structures without crystal structures.
Celeris Therapeutics	Deep Learning, Bioinformatics	It is a deep learning company that uses innovative, computer-based methods to degrade undruggable targets and validate lead drug candidates in automated lab

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
Quantitative Medicine	Active Learning, Machine Learning, quantum computing	CoRE™ is a dynamic and comprehensive in silico predictive modeling platform for constructing, assessing, validating and deploying exceedingly accurate predictive models to efficiently guide the testing process and solve complex drug discovery optimization problems. CoRE™ applies cutting edge machine learning techniques from three complementary informatics technologies: Supervised Learning, Transfer Learning and Active Learning.
Reverie Labs	Evolutionary algorithms, Machine Learning	ML-based structure based predictive models for potency and ADMET/PK properties of small molecules.
ReviveMed	Machine Learning, Deep Learning	ReviveMed's platform for the first time enables the rapid, high-throughput, and cost-effective application of metabolic data to discover new disease mechanisms for drug discovery and, simultaneously metabolomic biomarkers to identify which patients stand to benefit by targeting the disease mechanism.
Structura Biotechnology	Machine Learning (stochastic gradient descent and branch-and-bound maximum likelihood optimization)	The cryoSPARC System™ enables high-throughput structure discovery of proteins and molecular complexes from cryo-EM data with help of machine learning.
XtalPi	Quantum physics; Machine Learning	XtalPi's ID4 platform provides accurate predictions on the physiochemical and pharmaceutical properties of small-molecule candidates for drug design, solid-form selection, and other critical aspects of drug development.

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
BioXcel	Machine Learning, Deep Learning, cheminformatics	Bioxcel Corporation is a biopharmaceutical company pioneering the application of artificial intelligence and big data analytics integrated with drug development expertise.
C4X discovery	Machine Learning, Deep Learning, cheminformatics, bioinformatics	C4X innovative DNA-based target identification platform (Taxonomy3(R)) utilises human genetic datasets to identify novel patient-specific targets leading to greater discovery productivity and increased probability of clinical success. This is complemented by C4XD's novel drug design platform which comprises two innovative chemistry technologies, Conformetrix and Molplex, that combine 4D molecular shape analyses (based on experimental data) with best-in-class computational chemistry.
CytoReason	Machine Learning, Deep Learning, symbolic AI, cheminformatics, bioinformatics	CytoReason turns human clinical data into clear biology, to deliver data-driven target discovery and drug development. CytoReason's access to unmatched proprietary and public data, combined with cutting-edge machine learning technologies, creates their unique biological models of disease, tissue and drug.
Deep Genomics	Machine Learning, Deep Learning, bioinformatics	Deep Genomics is using artificial intelligence to build a new universe of life-saving genetic therapies.

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
Desktop Genetics	Bioinformatics, Machine Learning	Desktop Genetics is a recognised leader in genome editing technology, staffed by dedicated team of genome editing experts, bioinformaticians and data scientists, driven by the real-world impact of CRISPR technology. Their core technology, DESKGEN AI, was trained on the largest database of genome editing data in the world.
C4X discovery	Machine Learning, Deep Learning, cheminformatics, bioinformatics	C4X innovative DNA-based target identification platform (Taxonomy3(R)) utilises human genetic datasets to identify novel patient-specific targets leading to greater discovery productivity and increased probability of clinical success. This is complemented by C4XD's novel drug design platform which comprises two innovative chemistry technologies, Conformetrix and Molplex, that combine 4D molecular shape analyses (based on experimental data) with best-in-class computational chemistry.
Data4Cure	Machine Learning, Deep Learning, NLP	The Data4Cure platform's modular architecture allows independent system components to handle integration and advanced analysis of heterogeneous data types spanning molecular, phenotypic and clinical data, both structured and unstructured. Data are mapped to a dynamic biomedical ontology allowing cross-referencing and joint analyses across thousands of datasets and millions of publications.
Envisagenics	Machine Learning, Deep Learning, high-performance computing	Envisagenics' SpliceCore platform integrates proprietary machine learning algorithms, high performance computing, and RNA-splicing analytics to identify disease-specific alternatively spliced RNA that will function as therapeutic targets.

Computational Methods Used by the Most Advanced AI Companies

Company	Computational methods used	Technology Abstract
Genialis	Machine Learning, Deep Learning	Blending computational biology and AI-based methods, Genialis merges and models data at the intersection of clinical and translational medicine.
GNS Healthcare	Machine Learning, Deep Learning	GNS Healthcare AI technology integrates and transforms a wide variety of patient data types into in silico patients which reveal the complex system of interactions underlying disease progression and drug response.
Healx	Machine Learning, NLP, symbolic AI, cheminformatics, bioinformatics	Healx AI platform uses natural language processing (NLP) to extract disease knowledge from published sources and to complement biomedical databases and proprietary, curated data. The data is integrated in the form of the largest, rare disease-focused Knowledge Graph. It shows prioritised hidden and novel connections between drugs and diseases when explored by expert pharmacologists and biologists.
Owkin	Machine Learning, Federated Learning	Owkin combines the expertise in biology and machine learning to fuel precision medicine. Owkin's unique algorithms allow researchers to understand the model's conclusions and identify biomarkers. Owkin facilitates access to real-world data by therapeutic area through its data connect service. The company collaborates with companies to understand patient response to immunotherapy in a specific cancer.

20 Notable R&D Use Cases of AI Application in Biopharma



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Introduction to Most Innovative R&D Approaches of AI in Biopharma

The industry of AI in Biopharma continues to grow after a long period of skepsis. This is reflected in ongoing flow of investments and increase in the number of collaborations between pharmaceutical corporations and AI companies in 2021 to the previous years.

The Biopharma industry's growth is largely influenced by active engagement of leading pharmaceutical corporations in the AI-related investments. The number of scientific publications in the field of AI in Biopharma, and research collaborations between pharma companies and AI-expertise vendors are rapidly increasing, yet some Pharma corporations still being critical about AI applications.

Machine Learning and AI applications in pharmaceutical and healthcare industries leading to the formation of a new interdisciplinary field — data-driven drug discovery/healthcare. It will be crucial to hire top AI experts and interdisciplinary teams, especially for Big Pharma companies that are fighting to survive.

It is a main difference between Pharma and Biopharma fields that`s in the origin of their products. Biopharma utilizes living organisms (such as yeasts, bacterias, mammalian cells) which are capable to produce complexly structured products as proteins, hormones, RNA and DNA products, viruses capsids. Whereis Pharma relies on a classical chemical synthesis producing small drug molecule. However both industries may benefit of AI-driven applications. To develop new small drug molecules or biologically-derived products, AI-driven data processing serves as a tool that allows to minimise time consuming biological testings while helping to select the most promising products to test.

Trending and innovative R&D approaches of AI in Biopharma companies includes usage of:

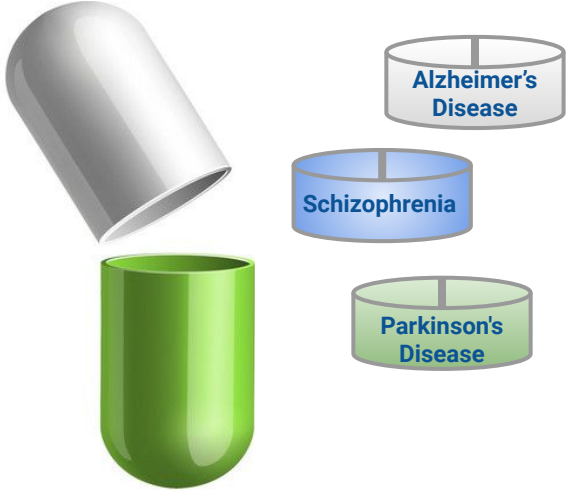


Most Innovative R&D Approaches of AI in Biopharma. Abbvie

AbbVie is a global, research-based biopharmaceutical company founded in 2013 following separation from Abbott. The company's mission is to use its expertise, dedicated people and innovative approaches to develop and market advanced therapies that address some of the complex and serious diseases.

AbbVie does have a confidential project listed with Atomwise. Also, in September 2016, together with its partner AiCure, AbbVie announced how its AI-based patient monitoring platform improved adherence in an AbbVie phase 2 schizophrenia trial.

Main focus areas:



The way AI is used:

- to visually confirm medication ingestion
- to increase medication adherence in patients
- to use data to assess effectiveness of treatment

Cooperation:

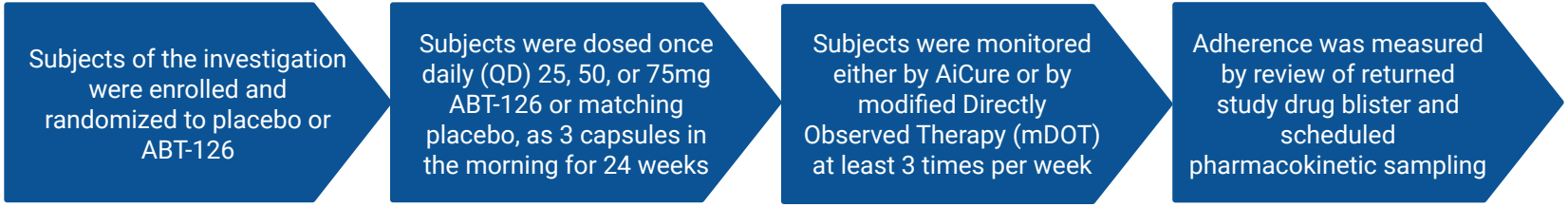
- AiCure
- Mission Therapeutics

Source: Crunchbase

How Abbvie Uses AI in R&D?

Abbvie and Mission Therapeutics collaboration is aimed at developing DUB inhibitors that promise to treat two currently incurable conditions, Parkinson's and Alzheimer's diseases. With over 50 million Americans struggling Alzheimer's and dementia, this AI partnership bringing treatment closer and hope for many.

1. Abbvie in cooperation with another AI-specialized company AiCure (clinically-validated artificial intelligence company that visually confirms medication ingestion on smartphones), announced that their study confirms that use of the AiCure Platform significantly increases medication adherence in patients with schizophrenia, as measured by drug concentration levels. The data was presented during the International Society for CNS Clinical Trials and Methodology (ISCTM) Scientific Sessions.



2. The sub-study was part of a larger Phase 2, multicenter, randomized, double-blind, placebo-controlled, dose-ranging, parallel-group, study in nonsmoking subjects with schizophrenia who were clinically stable. The AiCure platform was introduced in 10 of 31 US sites; subjects were monitored either by AiCure or by modified Directly Observed Therapy (mDOT) at least 3 times per week. In addition, adherence was measured by review of returned study drug blister and scheduled pharmacokinetic sampling.
3. Results: cumulative adherence, measured by study drug concentrations above the LLOQ (minimum required therapeutic level), were higher through 24 weeks for subjects monitored using the AiCure platform (89.7%) compared with subjects monitored using mDOT (71.9%). This research adds to the growing body of scientific evidence showing the advantages of using AI to increase statistical power and reduce sample size in clinical trials, thereby decreasing costs and accelerating drug development.

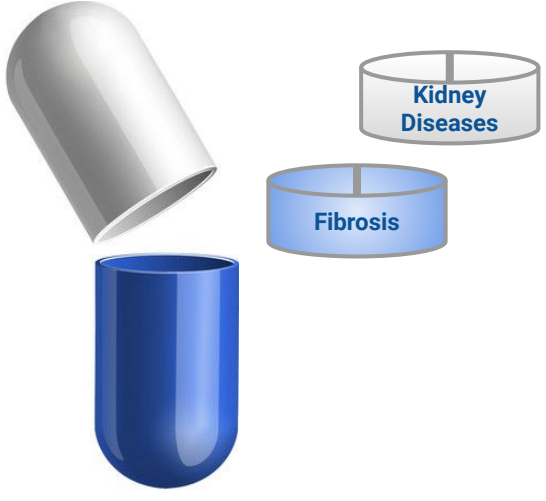
Source: AiCure, Blog.Benchsci, Healthcare Weekly

Most Innovative R&D Approaches of AI in Biopharma. AstraZeneca

AstraZeneca is a global, science-led biopharmaceutical company, whose medicines are used by millions of patients worldwide. Jim Weatherall, Vice President in AstraZeneca, said that data science and AI has the potential to transform the way they develop new medicines – turning yesterday's science fiction into today's reality with the aim of enabling the translation of innovative science into life-changing medicines.

AstraZeneca uses AI to combine information from multiple sources in order to draw more accurate conclusions than if science literature was analysed by human alone. AI also has the potential to find patterns in these graphs revealing previously unexplored hypotheses.

Main focus areas:



The way AI is used:

- to build disease understanding through knowledge graphs to integrate genomic, disease, drug and safety information
- to identify new targets for novel medicines
- for fast, accurate image analysis

Cooperation:

- Schrödinger

Source: AstraZeneca

How AstraZeneca Uses AI in R&D?

AstraZeneca focuses on the discovery, development and commercialisation of prescription medicines, primarily for the treatment of diseases in three therapy areas - Oncology, Cardiovascular, Renal & Metabolism and Respiratory. The company has turned to AI to cut development costs by improving the efficiency of repetitive tasks and engendering better-informed decision.

1. In AstraZeneca they using knowledge graphs - network of contextualised scientific data on genes, proteins, diseases and compounds and their relationship. AI also helps with this having the potential to find patterns in these graphs revealing previously unexplored hypotheses.The company's knowledge graphs integrate data of.



2. Discovering a potential drug molecule requires several years of detailed scientific research. AI is enabling us to rapidly generate novel ideas for potential treatment molecules using predictions based on large data sets. Having identified promising molecules, the next step is to synthesise the them in the laboratory. AI is starting to help here too – the science of synthesis prediction is rapidly evolving and scientist will soon be able to use AI to help deduce the best way to make drug molecules in the shortest time.

3. AI systems are trained to assist pathologists in analysing samples accurately and more effortlessly. This has the potential to cut analysis time by over 30%. For one of their AI systems, they implemented an approach inspired from how some self-driving cars understand their environment. They trained the AI system to score tumour cells and immune cells for a biomarker, called PD-L1, which has potential to help inform immunotherapy-based treatment decisions for bladder cancer.

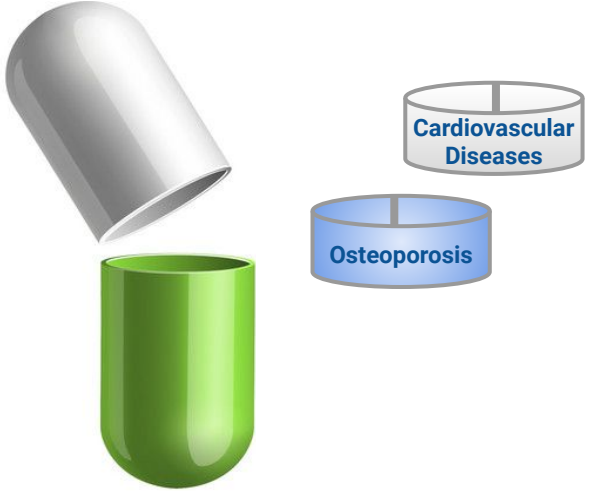
Source: AstraZeneca, TechCrunch

Most Innovative R&D Approaches of AI in Biopharma. Amgen

Amgen is one of the world's leading biotechnology companies committed to unlocking the potential of biology for patients suffering from serious illnesses by discovering, developing and manufacturing innovative human therapeutics.
AI is one of a series of emerging digital capabilities that are applied by Amgen.

Other technologies that company is leveraging include digital automation, natural language processing. Taken together, they do a whole host of activities across the company — from drug discovery and patient identification to optimized interactions with physicians.

Main focus areas:



The way AI is used:

- to boost the accuracy of risk predictions
- to provide personalized approach to patient care
- to support compliance via real-time answers with accuracy and consistency
- to use data to determine the most effective treatment

Cooperation:

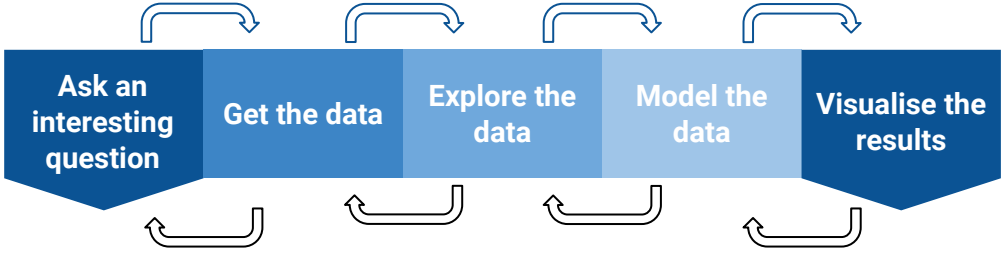
- Owkin

Source: Wired

How Amgen Uses AI in R&D?

Amgen is piloting a process using AI that has the potential to greatly enhance its ability to find patterns in manufacturing deviations and to prevent their recurrence. The AI tool will replace a manual, labor-intensive process with one that can look across large data sets and find correlations between obscure signals and events which the previous system could have missed.

1. While large company manufactures, purifies, and packages biotech drugs, a huge amount of diverse data is generated, not all of which is digitized. The focus of Amgen is the application of data science specifically in quality operations, using a data science process:



Quality data sciences creates solutions that unlock and leverage data. These solutions will efficiently provide insights and intelligence for the Quality Operation. This involves:

1) Ensuring data access; 2) Application of appropriate analysis methods to unlock information; 3) Meaningful visualisation.

2. Amgen have created a project team to look for a system algorithm that could replicate and perhaps improve upon the manual process. The goal was to build a product that could be deployed across the manufacturing network. Using an **agile development approach** and **natural language processing (NLP)** tools, the team developed a consistent algorithm that is able to reasonably replicate the manual process.

NLP is described as an AI technology that turns text into numbers, which can be read by a computer and used to identify similar records. Each record has a series of numbers associated with it that can be analyzed to create similarity scores. The records can then be clustered together. Those clusters can then be given to an subject matter expert, who can decide if there is trending and if action should be taken. Feedback can then be given to the algorithm, which can be adjusted.

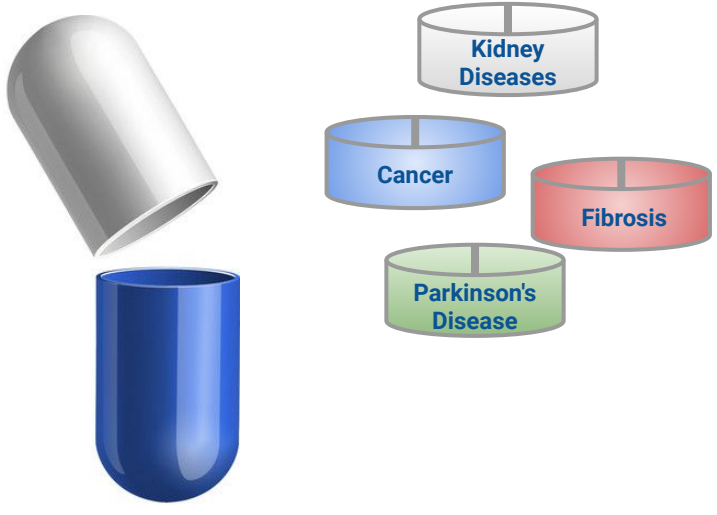
Source: Wired, Pharmaceutical Online

Most Innovative R&D Approaches of AI in Biopharma. BenevolentAI

BenevolentAI is the global leader in the application of AI for scientific innovation. The company's aim is to accelerate the journey from inventive ideas to medicines for patients. BenevolentAI integrates AI technologies at every step of the drug discovery process: from early discovery to late stage clinical development.

The company has developed the Benevolent Platform™ — a leading computational and experimental discovery platform that allows scientists to find new ways to treat disease and personalise medicines for patients. The Benevolent Platform™ focuses on three key areas: Target Identification, Molecular Design and Precision Medicine.

Main focus areas:



The way AI is used:

- to collect more diverse data
- to identificate specific drug target
- in molecular design
- in patient stratification

Cooperation:

- Neuropore Therapies
- Novartis



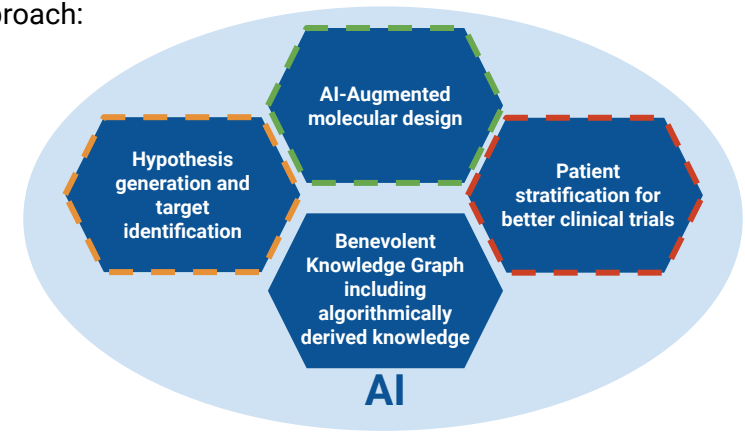
Source: Wired, Benevolent.ai

How BenevolentAI Uses AI in R&D?

BAI

The Benevolent Platform™ of computational and experimental technologies and processes draws on vast quantities of mined and inferred biomedical data and is built by their world-class scientists, researchers, and technologists, working side-by-side, to improve and accelerate every steps of the drug discovery process.

1. BenevolentAI uses AI to mine and analyse biomedical information, from clinical trials data to academic papers. The company's approach:



2. BenevolentAI has spent the last five years developing a knowledge pipeline that pulls data from various biomedical data sources and **curates and standardizes this knowledge via a data fabric**. This is fed into their proprietary **knowledge graph** which extracts and contextualises the relevant information. The knowledge graph is made up of a vast number of contextualised, machine curated relationships between diseases, genes, drugs and with over 20 types of biomedical entities.

3. Relation inference AI models help to predict **potential non-obvious disease targets** that may be overlooked. Their specific expression based models help to identify proteins, genes that express differently in a disease and healthy cell.

4. By leveraging advanced AI, the **EvoChem** product designs de novo compounds based on multiparametric optimisations with a scoring function that factors in all the properties the company is seeking to optimise for that molecule.

5. Company applies ML models to identify patient groups by the molecular signature of their disease and design, allowing to run faster clinical trials.

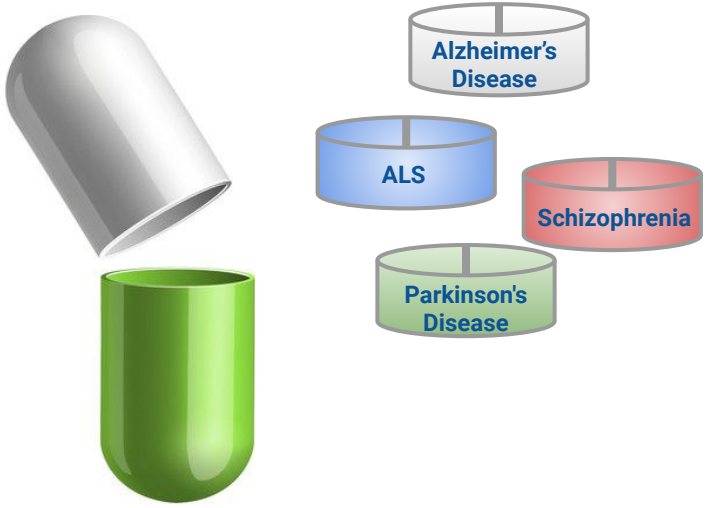
Source: Wired, Benevolent.ai

Most Innovative R&D Approaches of AI in Biopharma. Boehringer Ingelheim

Boehringer Ingelheim is one of the world's largest pharmaceutical companies, and the largest private one. The company's key areas of interest are: respiratory diseases, metabolism, immunology, oncology and diseases of the central nervous system.

Boehringer Ingelheim plans an ambitious project with artificial intelligence developer Lifebit, which aims to use natural language processing and AI programs to quickly digest international scientific publications along with real-world data from other open sources, the companies hope to establish the prevalence of any particular disease and discover whether it has begun to spread across national borders allowing Boehringer to set its research priorities accordingly.

Main focus areas:



The way AI is used:

- to develop drugs for emerging infections in preventive manner
- to reduce the time needed to discover a new drug
- to improve the quality of discovered drugs and molecules

Cooperation:

- Bactevo
- Bi X



Source: Boehringer

How Boehringer Ingelheim Uses AI in R&D?

Boehringer Ingelheim has partnered with UK-based AI tech company Bactevo to speed up its drug discovery efforts. In this collaboration, Boehringer will leverage Bactevo's AI-powered platform – Totally Integrated Medicines Engine platform (TIME) – to boost the efficiency, speed, and quality of drug discovery from small molecule lead compounds. As a result they reduce the time to take drugs to market to treat the conditions caused by defects in mitochondrial function. It was possible due to powerful drug research experience at Boehringer and state of the art TIME platform to discover new medicines for ALS, Parkinson's disease and Alzheimer's disease.

1. With the founding of BI X as independent subsidiary Boehringer Ingelheim will focus on breakthrough innovative digital solutions in healthcare from idea to pilot. The start-up will work closely together with all three business units of the company - Human Pharma, Animal Health and Biopharmaceuticals. It will provide a platform for collaborating with specialists in the field of data science and agile software development.

2. BI X will develop prototypes for new products and solutions and test them together with the company's business units in pilot phases. The business units will then use the successfully developed new products and solutions themselves and bring them to the market. This approach is to ensure that knowledge and experience accrued at BI X are being quickly integrated into the digital lab.

3. SoundTalks, an audio monitoring system for the early detection of respiratory diseases, is currently being tested in livestock farming. For humans the faster treatment can slow or even halt the progression of a disease. Particularly this SoundTalks is applicable for central nervous system disorders. Intelligent speech recognition software – via smartphone – will be able to analyze speech patterns, recognize risks, and thereby contribute to a reliable diagnosis and effective therapy. To sum up, SoundsTalks analytical audio algorithms can lead to the earlier diagnosis of diseases in humans and animals.

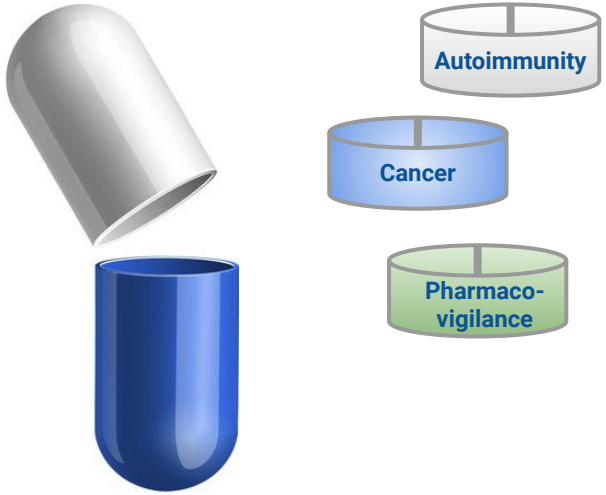
Source: eHealth News, pmlive

Most Innovative R&D Approaches of AI in Biopharma. Celgene

The vision of **Celgene** is to build a major biopharmaceutical corporation while focusing on the discovery, the development, and the commercialization of products for the treatment of cancer and severe, immune, inflammatory conditions. There are more than 300 clinical trials at medical centers using compounds from Celgene. The company is transforming Pharmacovigilance to drive patient safety.

Pharmacovigilance (also known as drug safety) aimed to detects and prevents adverse effects by evaluating, and acting upon them. The value of using AI methodologies in Pharmacovigilance is compelling; however, as drug safety is highly regulated, acceptability will require assurances of quality, consistency, and standardization.

Main focus areas:



The way AI is used:

- to speed up the discovery of drug candidates for for cancer and autoimmune diseases
- to identify and standardize Pharmacovigilance elements
- to develop, review and validate cognitive services
- to increase operational efficiency, consistency, quality of data collection, and signal detection

Cooperation:

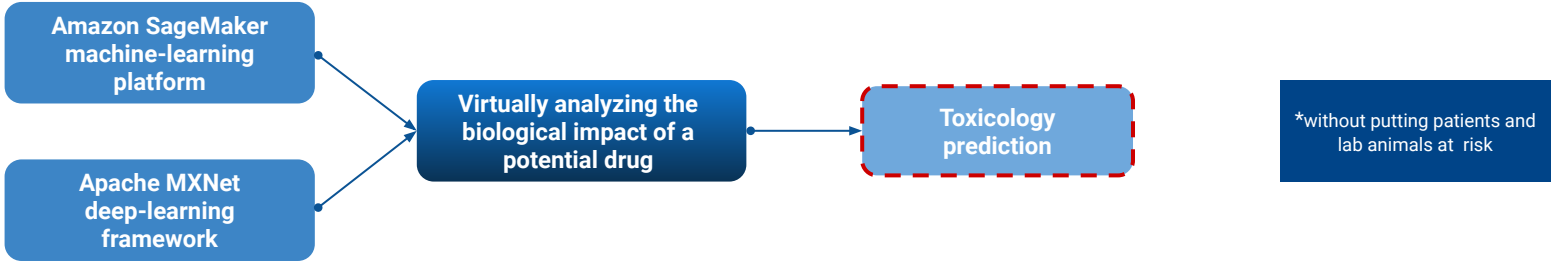
- GNS Healthcare

Source: Springer

How Celgene Uses AI in R&D?

Celgene force boosts AI implementation in drug discovery, particularly machine learning and deep learning. Machine learning involves computing techniques that analyze vast amounts of information, including abstract data. Deep learning takes that even further, using code that attempts to mimic the brain's ability to recognize patterns in unstructured data.

1. In the past, researchers relied on imperfect image-processing algorithms to analyze data of the tested samples. With tens of thousands of images, it required a huge expenditure of time and effort. But using deep learning, images can be processed almost instantaneously and more precisely. The platforms assisting with image analysis, includes:



2. Pharmaceutical research heavily revolves around complex algorithms to predict how certain compounds will interact with the patients. To this end, Celgene uses high-performance **Amazon EC2 P3** instances powered by NVIDIA Tesla V100 Tensor Core GPUs (graphics processing units) to process the complexity. These NVIDIA GPUs have thousands of cores that accelerate the training of machine-learning models (which can, for instance, test the effectiveness of a drug faster and with higher accuracy). The results have been game changing: **a model that once took two months to train can now be trained in four hours**.

3. AI is used to identify areas across the drug safety value chain. It can be augmented by cognitive service solutions using the methodologies of contextual analysis and cognitive load theory. It will also provide a framework of how to validate these PV cognitive services leveraging the acceptable quality limit approach.

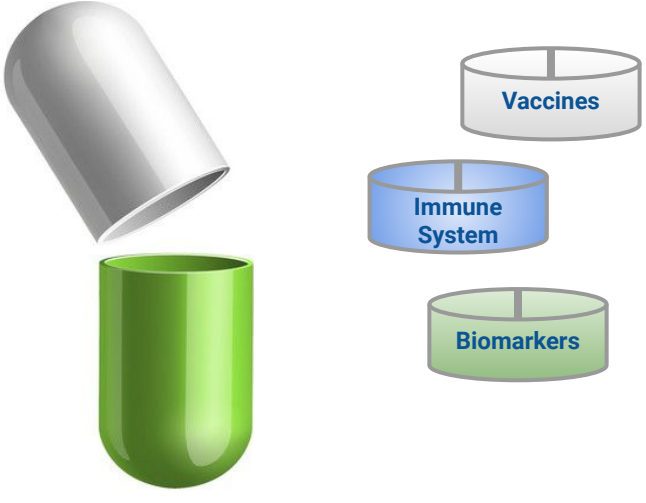
Source: Springer, Labiotech, AWS Amazon

Most Innovative R&D Approaches of AI in Biopharma. GSK

GlaxoSmithKline has 3 global businesses - Pharmaceuticals, Vaccines, Consumer Healthcare - that research, develop and manufacture innovative pharmaceutical medicines, vaccines and consumer healthcare products. Their R&D approach focuses on science related to the immune system and use of advanced technologies.

GlaxoSmithKline has many deals with different companies such as Exscientia, Insilico Medicine, Insilico Biotechnology to use new computer modelling systems to bring differentiated, high-quality and needed healthcare products.

Main focus areas:



The way AI is used:

- to improve the discovery of drugs, biomarkers, and new vaccines
- to optimase interpretation of genetics and genomic data
- to understand the effect of interventions on diseases

Cooperation:

- Exscientia
- Insilico Medicine



Source: GSK

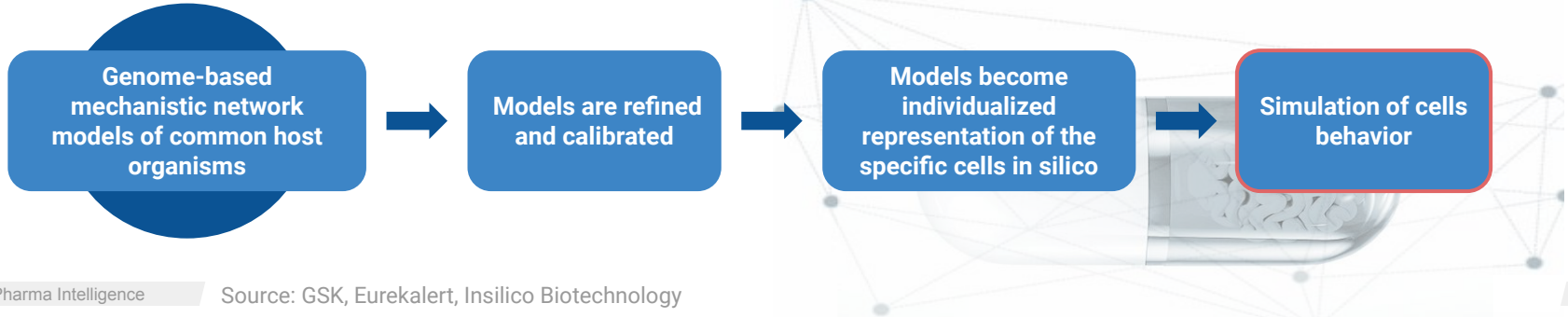
How GSK Uses AI in R&D?

The goal of GSK is to achieve a sustainable flow new treatments, utilising modalities such as small molecules, antibodies, antibody drug conjugates and cellular therapies, either alone or in combination. Their research focuses on science related to the immune system and human genetics, while leveraging advanced technologies including functional genomics, AI and machine learning.

1. According to the GSK and Exscientia collaboration, AI enabled platform will be applied and combined with the expertise of GSK, in order to discover novel small molecules for up to 10 disease-related targets, nominated by GSK across multiple therapeutic areas.

2. GSK evaluates Insilico Medicine technology in the identification of novel biological targets and pathways of interest to GSK to enhance its drug discovery process.

3. GSK uses Insilico' Biotechnology technology platform to analyse predictive simulations of cell responses. As a result a big number of cell response scenarios will be generated. This data will be utilized to largely reduce the number of experiments necessary for the drug development. It's reached by selecting to replicate the conditions with desirable cell response scenarios among others. This has the potential to cut down the time taken to research Vaccine development and could therefore speed up the time-to-market for candidate Vaccines in GSK's research portfolio. Insilico's technology is built around Insilico Cells:



Source: GSK, Eurekalert, Insilico Biotechnology

Most Innovative R&D Approaches of AI in Biopharma. Gilead

Gilead is focused on developing and delivering medications that advance the treatment of life-threatening diseases. The commercial success of their products provides them with the resources to generate new clinical data defining their profiles and supports their development of new therapeutic advancements. As they bring new products into clinical development, their goal remains the same – to discover, develop and commercialize therapeutics that advance patient care.

In spring 2019 Gilead and insitro announced that the companies have entered into a strategic collaboration to discover and develop therapies for patients with nonalcoholic steatohepatitis (NASH).

Main focus areas:



The way AI is used:

- to create disease model
- to discover new targets that influence disease progression and regression

Cooperation:

- insitro

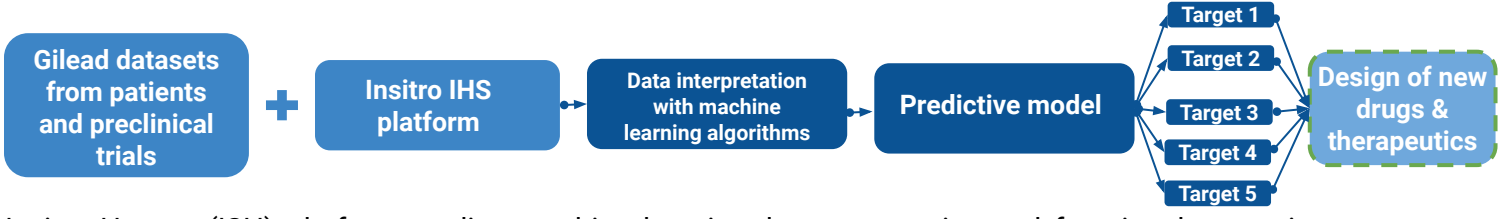


Source: Gilead

How Gilead Uses AI in R&D?

According to John McHutchison, the company's Head of Research and Development, Gilead is committed to researching and developing treatments for patients living with NASH, particularly those with advanced fibrosis who have the greatest unmet need. Gilead is able to utilize deep learning to explore the scientific underpinnings of the biology and clinical spectrum of NASH, with the goal of accelerating the development of highly effective treatment options for patients with this disease.

1. The startup's Insitro Human platform combines AI with human genetics and genomic data to provide insights into the disease and its progression, propose forms of treatment and predict patient responses to those therapies. With that information, Gilead is planning to develop up to five proposed treatments for NASH.
2. By generating functional genomic data sets that align with patient data, and interpreting those data via machine learning algorithms, Insitro builds predictive models that can accelerate target selection and the design of effective therapeutics. The company is building a high-throughput biological data factory based on state-of-the-art bioengineering technologies. Its allowing the creation of large data sets that lately given for analysis to machine learning algorithms. Such approach is able bear on key bottlenecks in drug development.



3. The Insitro Human (ISH) platform applies machine learning, human genetics and functional genomics to generate and optimize unique in vitro models and drive therapeutic discovery and development. The ISH platform provides insights into disease progression, suggest candidate targets, and predict patient responses to potential therapeutic interventions. Gilead can advance up to five targets identified through this collaboration and is responsible for further drug development against these targets.

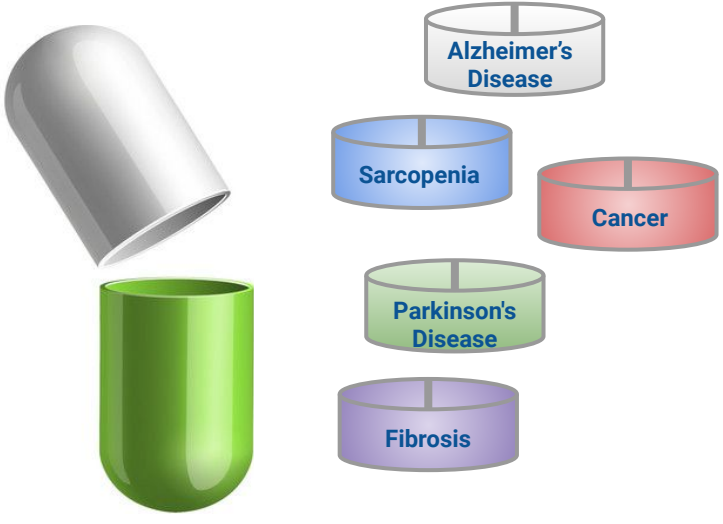
Source: Wire, GEN, Beckershospitalreview

Most Innovative R&D Approaches of AI in Biopharma. Insilico Medicine

Insilico Medicine, Inc. is a bioinformatics company located at the Emerging Technology Centers at the Johns Hopkins University Eastern campus in Baltimore. It utilizes advances in genomics, big data analysis and deep learning for in silico drug discovery and drug repurposing for age-related diseases. The company pursues internal drug discovery programs and geroprotector discovery and provides services to pharmaceutical companies.

Combining genomics, big data analysis, and deep learning, the company has been using artificial intelligence algorithms to potentially discover the next world-changing drug.

Main focus areas:



The way AI is used:

- to find cheaper and faster ways to discover drug molecules
- to find new biological targets for existing drugs
- to validate the targets, using novel chemistry

Cooperation:

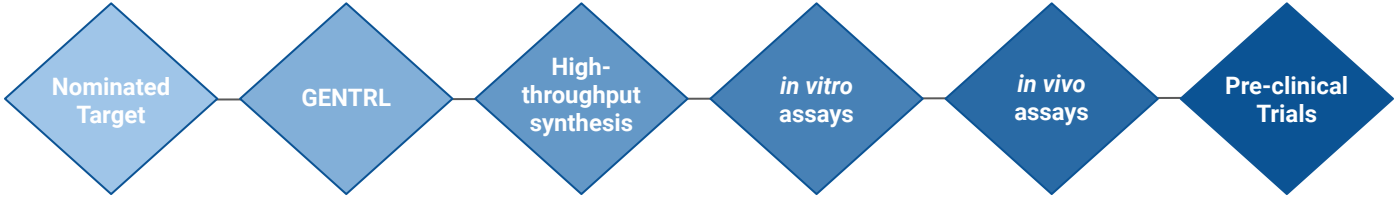
- BioTime
- Juvenescence AI Limited
- Bitfury

Source: Eurekalert, Insilico

How Insilico Medicine Uses AI in R&D?

Next-generation AI developed by Insilico Medicine can be used to validate, assess and improve the quality of biological experiments as well as learn using large volumes of heterogeneous data without human intervention. Multiple new methodologies including the feature importance, deep feature selection and deep pathway analysis among the others can provide the biologically-relevant interpretation by AI systems.

1. Since 2016, Insilico Medicine researchers have been working to get GANs (Generative Adversarial Networks consisting of two distinct neural networks) to "invent" new molecules with drug-like properties. In 2017, they combined it with another type of groundbreaking AI in the form of Reinforcement Learning. Reinforcement Learning is built around game-like situation where AI trained by trials and errors. It helps to train algorithms to serve for autonomous tasks.



2. Insilico Medicine has developed GENTRL (Generative Tensorial Reinforcement Learning), a new artificial intelligence system for drug discovery that dramatically accelerates the process from years to days (from 3 years to 21 days before first synthesis and trials). In the industry's first successful experimental validation of such AI technology for drug discovery in cells and animals, Insilico successfully tested the technology by creating a series of entirely new molecules capable of combating disorders like fibrosis.

3. The system bucks the standard brute-force approach for AI drug development, which involves screening millions of potential molecular structures looking for a viable fit, in favor of a creative AI algorithm that can imagine potential protein structures based on existing research and certain preprogrammed design criteria. Insilico's system initially produced 30,000 possible designs, which the research team whittled down to six that were synthesized in the lab, with one design eventually tested on mice and exhibited promising results.

Source: Biospace, Digital Trends, Business Insider

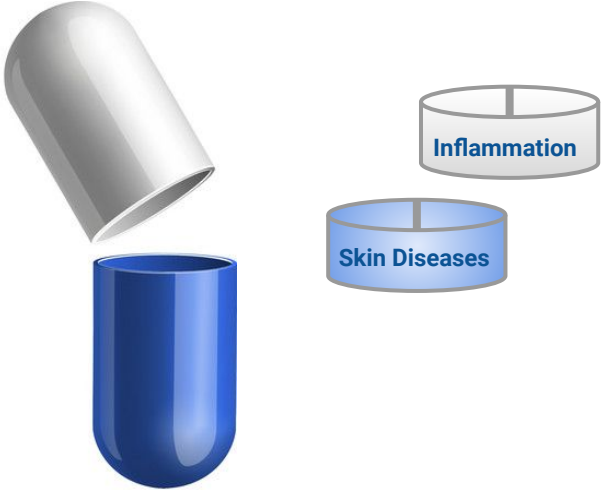
Most Innovative R&D Approaches of AI in Biopharma. Nuritas

NURITAS

Nuritas is revolutionising the discovery of novel, natural and active ingredients that were tasted in scientific research labs. The company's disruptive computational approach to discovery uses artificial intelligence and genomics to, for the first time ever, rapidly and efficiently predict and then provide access to the most health-benefiting components hidden within food, called bioactive peptides.

Their bioactive peptides provide patented innovative solutions to companies needing new therapeutic options to deal with significant unmet medical needs. The Bioactive Peptides they discover have the potential to offer new and innovative treatments for some of the illnesses that are becoming more prevalent as the world population continues to expand and age.

Main focus areas:



The way AI is used:

- to predict and identify novel bioactive peptides
- to deliver efficient health-related solutions

Cooperation:

- BASF

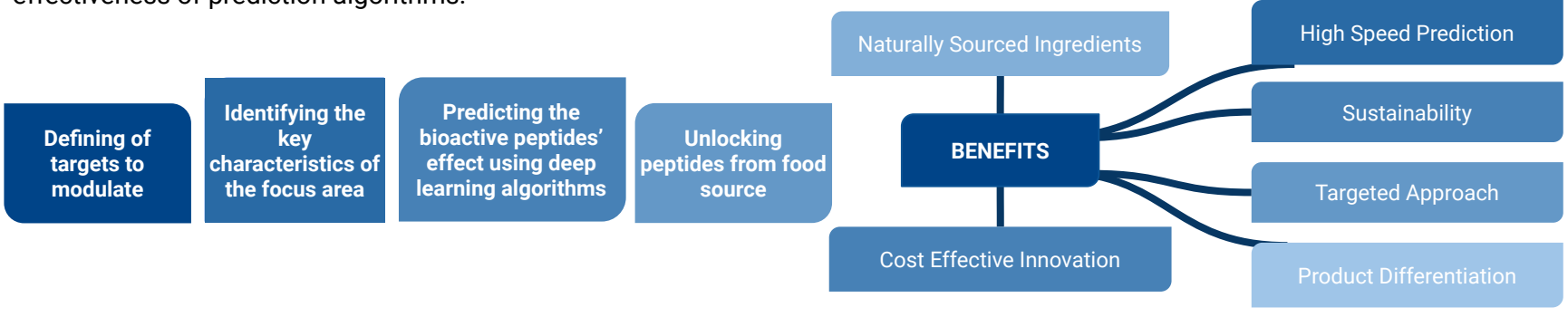


Source: Nuritas

How Nuritas Uses AI in R&D?

NURITAS At Nuritas, they recognise the vast untapped potential that exists in naturally occurring Bioactive Peptides. Their unique discovery platform targets, predicts and unlocks these natural ingredients to provide new solutions and opportunities across a wide range of application areas.

1. They begin the discovery process by defining targets they wish to modulate, then they use AI-based proprietary search tools to identify the characteristics specific to their area of focus. The most up-to-date scientific knowledge is used to maximise the efficiency and effectiveness of prediction algorithms.



2. Having begun the discovery process as above, Nuritas takes advantage of multiple proprietary AI algorithms, including deep learning. Using these, they are now able to predict which novel bioactive peptides deliver the effect that they are seeking. Their approach cuts out thousands of hours of trials and errors.

3. Their library of plant and animal derived Bioactive Peptides have gone through hundreds of millions of years of selective evolution to become the most potent repairers, healers and protectors.

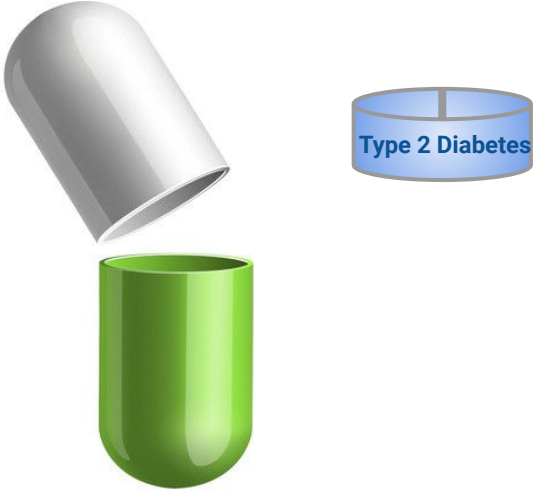
Source: Nuritas

Most Innovative R&D Approaches of AI in Biopharma. Novo Nordisk

Novo Nordisk is a global healthcare company with more than 95 years of innovation and leadership in diabetes care. Their heritage has an experience and capabilities that also enable them to help people defeat other serious chronic diseases. Among them haemophilia, growth disorders and obesity.

Novo Nordisk cooperates with e-Therapeutics to use its AI-based drug discovery technology to find new therapies for type 2 diabetes. e-Therapeutics uses a suite of powerful computational tools to augment and interrogate the large amount of biological data currently available in both public and private databases.

Main focus areas:



The way AI is used:

- to identify novel intervention strategies
- tease out previously unknown disease processes and pathways
- to form the basis for new therapies by discovering new biological disease-associated pathways

Cooperation:

- e-Therapeutics

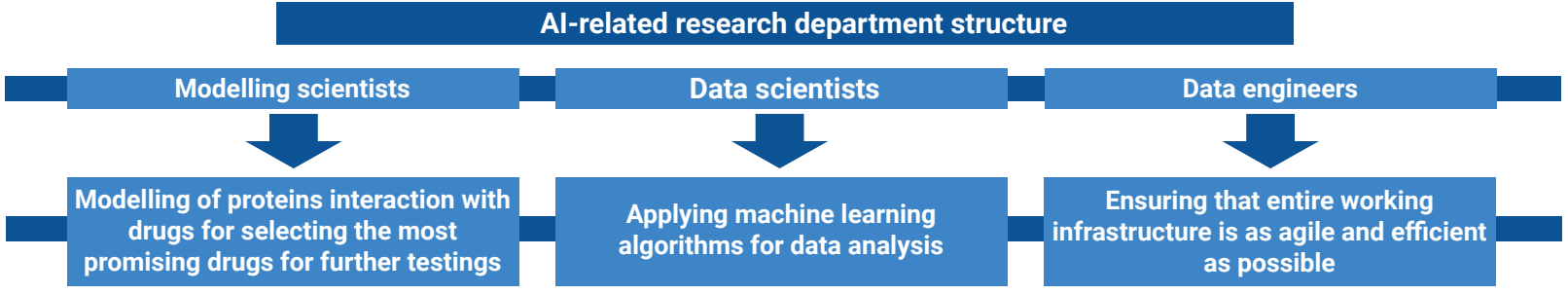


Source: Pharma Forum

How Novo Nordisk Uses AI in R&D?

1. Company's scientists use AI to improve and accelerate active pharmaceutical ingredient (API) and drug product (DP) designs of new peptides and biologics. They do it by using techniques such as machine learning and state of the art data analysis, e-therapeutics creates and analyses network models of disease to identify proteins that could be a treatment target.

They have access to advanced state-of-the-art protein modelling software and are applying data science tools and prediction models to a variety of biological and chemical data, including high-throughput analytical data and images.The company's research approach more realistically reflects the diseases models with its multiple and interconnected cellular pathways. Novo Nordisk has a research centre in Oxford, where visiting researchers are working with Oxford University academics to advance development of therapies for type 2 diabetes.



2. Novo Nordisk is the first pharma partner to sign up to use the GAIN platform, which taps into genome-wide association study (GWAS) data to find mutations in DNA linked to diseases. It is also bridges the gap between genetic susceptibility and disease mechanism. While many gene variants discovered using GWAS studies often do not map to a plausible biological mechanism, e-Therapeutics "network biology" approach can improve the hit rate. Using GAINs, the company will be able to interrogate genomics data from patients with complex, polygenic disease and shed new light on important biological pathways for particular groups of patients.

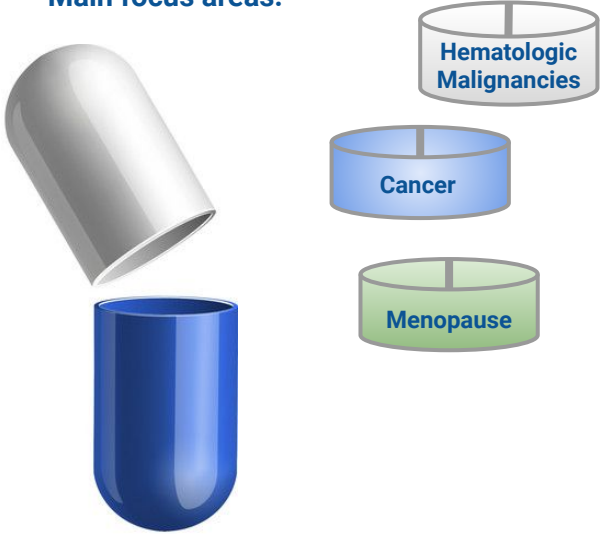
Source: Novo Nordisk, Pharma Forum

Most Innovative R&D Approaches of AI in Biopharma. Pfizer

Pfizer is a leading biopharmaceutical company with a powerful R&D centers. They apply modern science approaches to deliver innovative therapies that extend and improve lives. The company's products are the results of 1500 scientists overseeing more than 500,000 lab tests and over 36 clinical trials before the first prescription.

Pfizer in late 2016 announced a collaboration with IBM Watson for drug discovery. Pfizer is using IBM's AI technology on its immuno-oncology research, a strategy of using a body's immune system to help fight cancer. Based on their research, this appears to be one of the first significant uses of Watson for drug discovery.

Main focus areas:



The way AI is used:

- to uncover new information related to patient needs
- to analyze massive volumes of disparate data sources, including licensed and publicly available data
- to discover new drug targets and alternative drug indications

Cooperation:

- IBM Watson

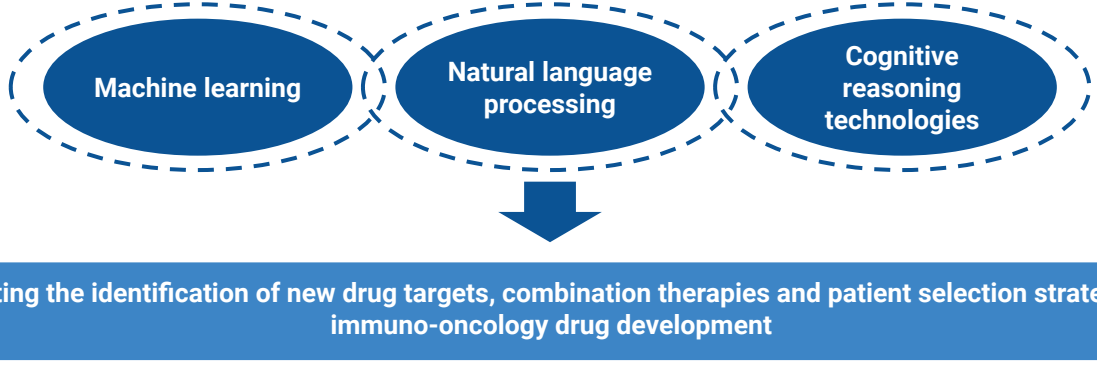
IBM Watson

Source: Pfizer

How Pfizer Uses AI in R&D?

Pfizer is among the healthcare companies heavily investing in AI. Its teamed with IBM Watson to identify better targets for cancer during the discovery phase. Pfizer is also cooperated with Concerto HealthAI to to apply real-world datasets and AI techniques to develop new and more precise treatment options for patients with solid tumors and hematologic malignancies.

1. Pfizer is one of the first organizations worldwide to deploy Watson for Drug Discovery, and the first to customize the cloud-based cognitive tool:



2. Pfizer uses newly launched Watson for Drug Discovery, a cloud-based system that aims to help life sciences researchers discover new drug targets and alternative drug indications. The average researcher reads between 200 and 300 per year, while Watson for Drug Discovery has ingested 25 million Medline abstracts, more than 1 million full-text medical journal articles, 4 million patents and is regularly updated. Watson for Drug Discovery can be augmented with an organization's private data such as lab reports. It can help researchers look across disparate data sets to surface relationships and reveal hidden patterns through dynamic visualizations.
3. AI systems are used in progressive ways to analyze data, to uncover new information or insights related to patient needs.

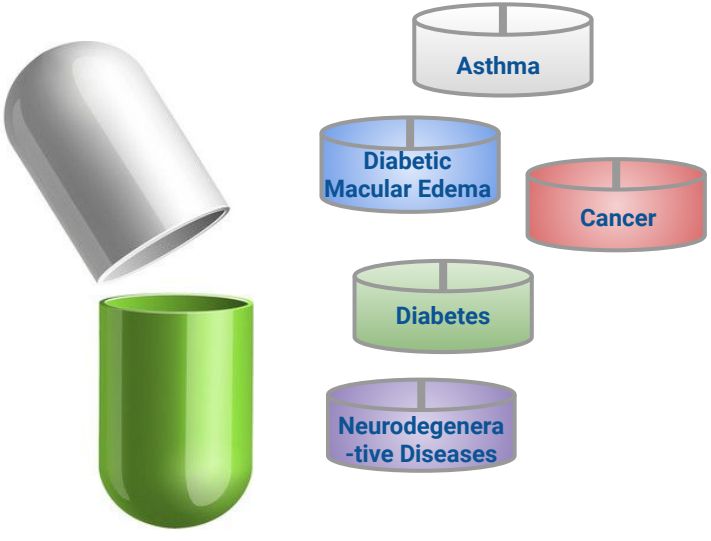
Source: Pfizer, Medtechdive, Pfizer

Most Innovative R&D Approaches of AI in Biopharma. Roche

Roche divests two businesses: fragrances and flavours, and vitamins and fine chemicals. As a research-driven company committed to innovation, the Group's Pharmaceuticals and Diagnostics Divisions supply products spanning the healthcare spectrum, from the early detection and prevention of disease to diagnosis and treatment.

Sensors, wearables, IOT, blockchain, high performance compute, Machine Learning and Deep Learning are drivers and enables of digital transformation of Roche`s entire Pharma value chain. AI is expected to have a dramatic impact on medicine that Roche provides.

Main focus areas:



The way AI is used:

- to improve the ability to diagnose disease
- to select the best treatments for individual patients
- to De novo compound design
- to facilitate selection of better disease`s target

Cooperation:

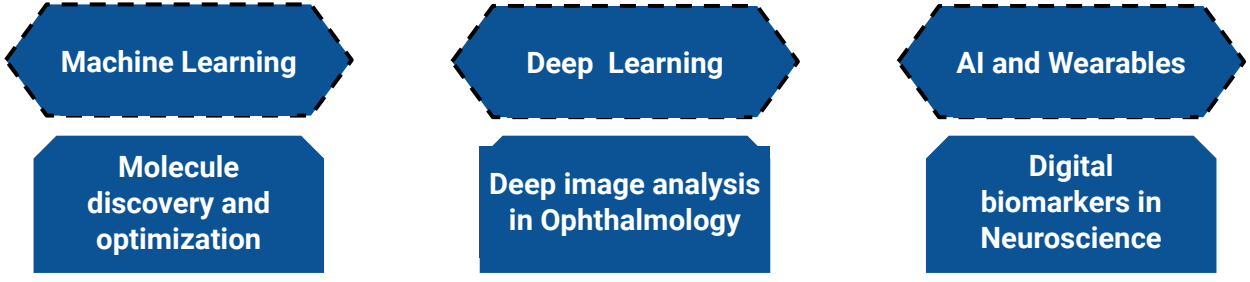
- Owkin

Source: Roche

How Roche Uses AI in R&D?

With the advent of more sophisticated digital technologies, personalised healthcare is entering a new phase. It expanding from companion diagnostics to a more holistic view of patient health generated from a wide variety of data sources. The way Roche can develop and bring medicines to patients in a much more targeted fashion, its via combining and standardising patient health data, using AI algorithms processing and wearable devices data.

1. Examples of transformative digital use cases across different areas, modalities and pipeline phases:



2. AI could revolutionise the way ophthalmologists diagnose diabetic macular edema (DME), a complication of diabetes that causes a thickening of the retina that can lead to irreversible blindness if left untreated. The best way to prevent DME is through regular eye exams that use a technique called colour fundus photography (CFP) and optical coherence tomography (OCT). The company's researchers use deep learning to teach computers how to estimate macular thickness from CFP images, making DME diagnosis easier. They upload to AI program a large set of CFP and OCT data from participants in two large DME clinical trials.

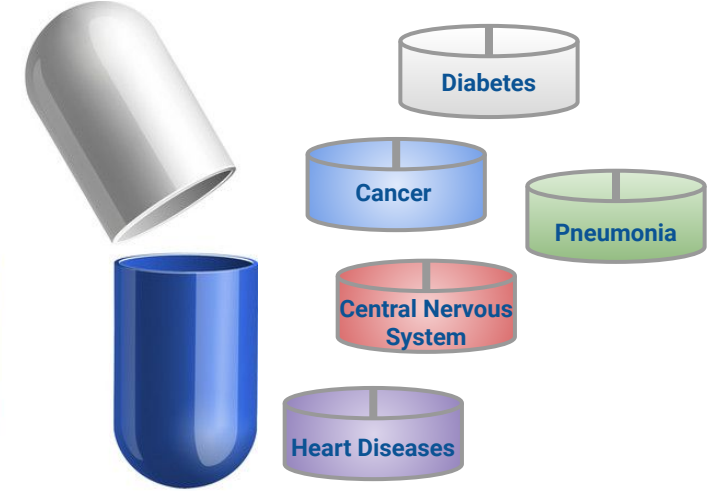
   The deep learning system examined a total of 17,997 CFP images from ~700 patients and compared them with corresponding OCT thickness measurements. Deep learning could also do predicting the actual OCT measurement of the macula's thickness from a CFP image if it was of sufficient quality.

Source: Roche, Roche

Most Innovative R&D Approaches of AI in Biopharma. Sanofi

Sanofi is a healthcare company engaged in the research, development, manufacturing, and marketing of innovative therapeutic solutions. It covers areas such as diabetes, vaccines, small molecule drugs, consumer healthcare, etc. Its products includes prescriptions and over-the-counter drugs for thrombosis, cardiovascular disease, diabetes, central nervous system disorders, oncology and internal medicine, vaccines.

Main focus areas:

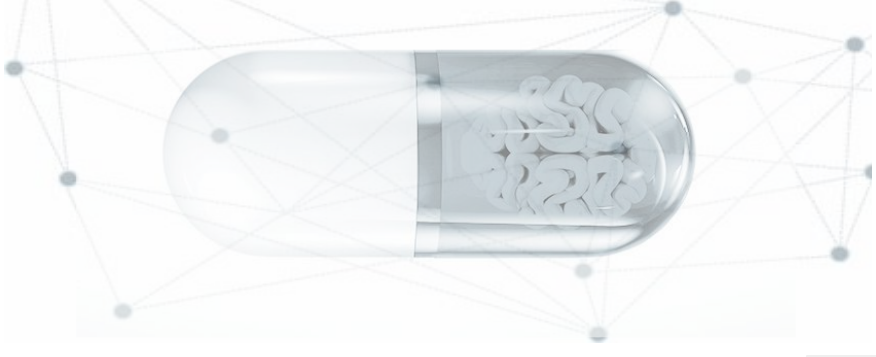


The way AI is used:

- to provide remote (ehealth) connection between patients and doctors
- to diagnose diseases at early stage
- to decentralize clinical trials
- to improve marketing strategies

Cooperation:

- Google



Source: Crunchbase

How Sanofi Uses AI in R&D?

Big data and a better understanding of the human genome are also providing medical professionals with better tools to make faster, more accurate diagnoses and deliver more personalized treatments. Large, multinational databases of clinical data called patient registries can also play a key role in the study of rare diseases. Additionally, Sanofi IT will be modernizing its infrastructure by migrating some existing business applications to Google Cloud Platform (GCP).

Mouthlab

1. MouthLab is a single, noninvasive device that measures more than 10 different health indicators in less than a minute. The AI-powered system uses the patient's mouth and hand to measure in real-time vital health signs typically monitored at the doctor's office, including respiratory rate, pulse, electrocardiogram, blood oxygen saturation, temperature, blood pressure, and several lung functions. In addition, the device connects to the cloud, so patient data is accessible in real time to physicians and caregivers. By making this data easily available, Sanofi aims to reduce hospitalizations, patient costs and risks.

Wavy Assistant

2. Wavy Assistant delivers continuous real-time heart health monitoring using voice and AI solutions. After a patient's data is collected and analyzed, Wavy can provide advice tailored to that individual. Our heart health monitoring solution uses a smart home speaker as its main user interface, which allows customers to interact with their heart health easily through a natural conversation instead of a mobile app. If the system detects something is wrong, Wavy instantly sends an emergency signal to designated doctors, friends and family. It can also trigger an immediate alert during emergency situations. Almost all heart attacks and strokes happen at home and most of the damage occurs because the emergency services are called too late.

LIFEdata

3. LIFEdata is an intuitive, easy to use AI platform that automates personally tailored conversational experiences across all channels. In terms of user experience, healthcare is no different than any other industry.

Source: Sanofi

How Sanofi Uses AI in R&D?

ChatbotPack.com

4. Computers that understand humans through text and voice are Sanofi's solution for healthcare with many applications. Voice technologies are used to detect, e.g. flu—or a general decline in condition—before it gets worse (e.g. pneumonia). A device in the elderly person's home can analyze changes in a person's voice and detect symptoms early on. It helps homecare and home nurses to detect their patients' illness before they need hospital care.

Mentalab

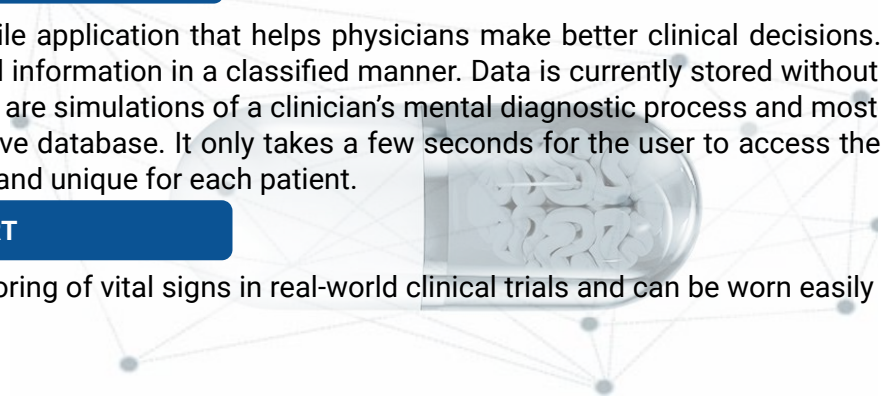
5. Mentalab combines a wearable patch that can measure electrocardiogram biosignals continuously, with a cloud-based analysis service to diagnose and monitor cardiac and respiratory conditions. The patch can be applied by patients directly, and worn throughout their daily activities, while data is transmitted and analyzed seamlessly. In site-less clinical trials, this solution can increase patient engagement and participation rates.

NeuroAdvise

6. NeuroAdvise is a clinical decision support tool available as a mobile application that helps physicians make better clinical decisions. This system can archive all demographic and clinical patient-related information in a classified manner. Data is currently stored without patient identity according to time and date. NeuroAdvise algorithms are simulations of a clinician's mental diagnostic process and most of the important diagnostic factors are included in its comprehensive database. It only takes a few seconds for the user to access the list of differential diagnosis, which are sorted in order of probability and unique for each patient.

CART

7. A ring-design cardio tracker, or CART, can provide continuous monitoring of vital signs in real-world clinical trials and can be worn easily in daily life.



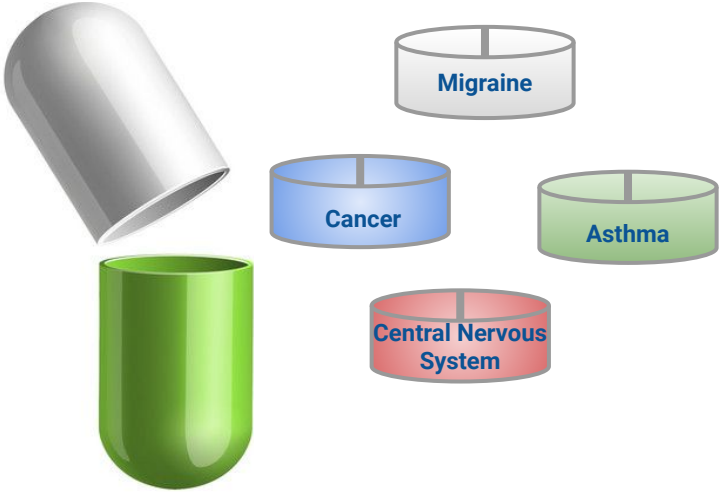
Source: Sanofi

Most Innovative R&D Approaches of AI in Biopharma. Teva

Teva is investing in both original biologic medicines and in biosimilars (highly similar versions to specific innovator biologics) to help patients around the world. The company is focused on treatments for the central nervous system, respiratory conditions and on the field of oncology. Teva uses the help of AI for development of 'Single device location-algorithm pair' for optimal treatment of impaired mobility resulting from ageing and chronic disease as well as for digital technology, including body worn sensors.

In cooperation with IBM Research, Teva focuses on two key healthcare areas: the discovery of new treatment options and improving chronic disease management.

Main focus areas:



The way AI is used:

- to improve chronic disease management
- to discover new treatment options
- to repurpose already existing drugs

Cooperation:

- IBM Research



Source: Startuphub, 7wdata

How Teva Uses AI in R&D?

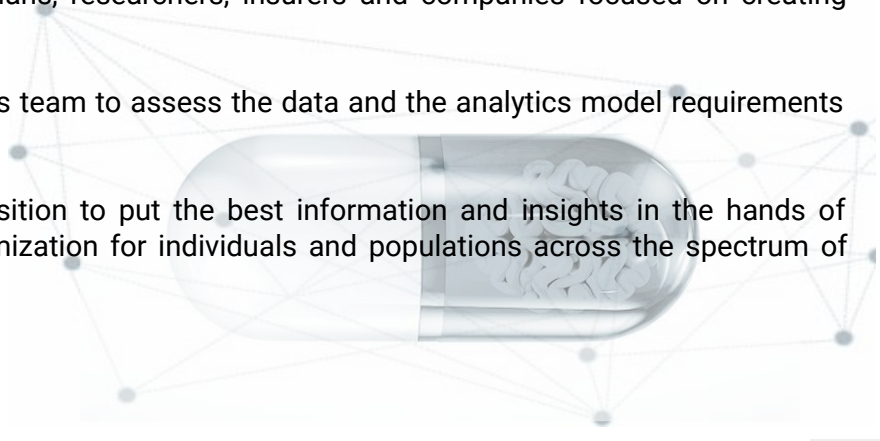
In cooperation with IBM Research, Teva focuses on two key healthcare areas: the discovery of new treatment options and improving chronic disease management. Teva's AI projects are based on the IBM Watson Health Cloud, that is a health-data enabled platform-as-a-service which is designed to help healthcare organizations derive individualized insights and obtain a more complete picture of the multiple factors that can affect people's health based on machine learning.

1. Teva has chosen the IBM Watson Health Cloud as a preferred global technology platform and managed to build solutions designed to help millions of individuals worldwide with complex and chronic conditions such as asthma, pain, migraine and neurodegenerative diseases. In addition, a joint Teva-IBM Research team will deploy Big Data and machine learning technology to create disease models and advanced therapeutic solutions.

2. Watson is a groundbreaking cognitive computing platform that represents a new era of computing based on its ability to interact in natural language, process vast amounts of Big Data to uncover patterns and insights, and learn from each interaction. The Watson Health Cloud provides an open development platform for physicians, researchers, insurers and companies focused on creating health and wellness solutions.

3. IBM's Global Business Services works closely with a Teva Analytics team to assess the data and the analytics model requirements for the Real World Evidence e-health solution.

4. By building on the Watson Health Cloud, Teva is in a unique position to put the best information and insights in the hands of physicians, care teams and patients, to empower treatment optimization for individuals and populations across the spectrum of acute and chronic conditions.



Source: 7wdata, Teva

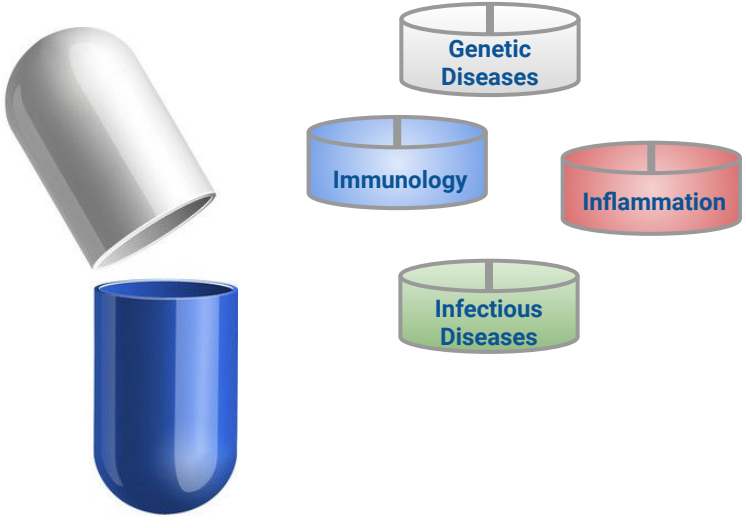
Most Innovative R&D Approaches of AI in Biopharma. Recursion Pharmaceuticals

Recursion Pharmaceuticals is a digital biology company, which applies AI for the development of its drug discovery platform and pipeline.

The Recursion Pharmaceuticals' integrates technological innovations across biology, chemistry, automation, data science and engineering to industrialize drug discovery.

The company currently has 4 clinical stage programs and 6 preclinical candidates in its pipeline.

Main focus areas:



Recursion Operating System ('OS') consists of:

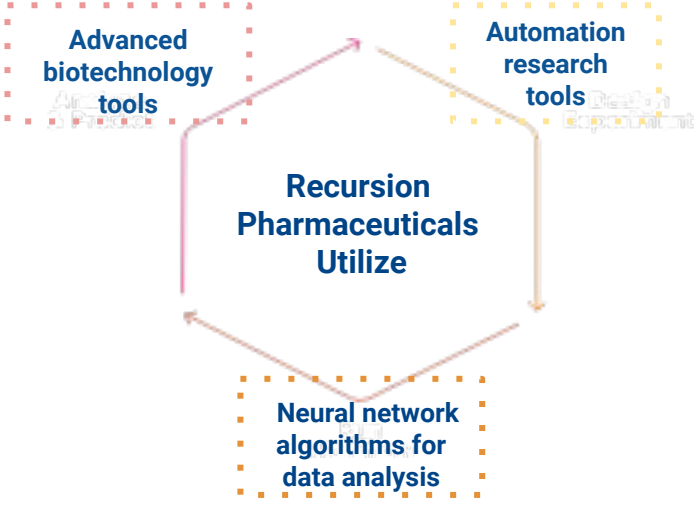
- **Infrastructure Layer** is a highly synchronized network created to design, execute, aggregate, and store biological and chemical data
- **Recursion Data Universe** is a high-dimensional biological and chemical dataset spanning multiple different data modalities
- **Recursion Map** is a software application designed to process and translate data from the Recursion Data Universe



How Recursion Pharmaceuticals Uses AI in R&D?

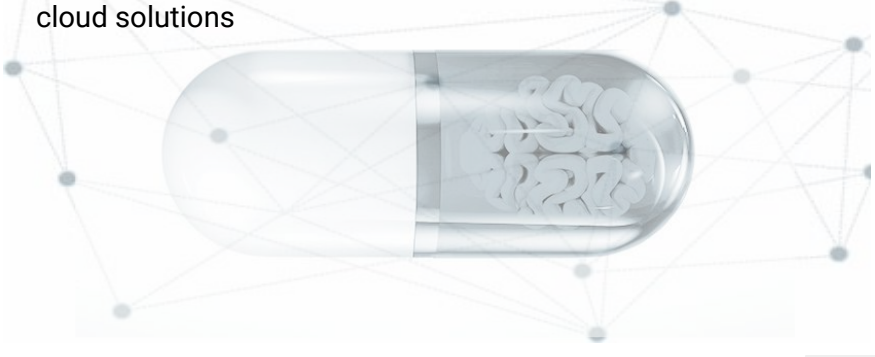
The Recursion Pharmaceuticals platform is a continuous, iterative loop of "biology and bits" which combines wet lab biology experiments that are executed automatically with machine learning algorithms computing the results in a cloud.

The company creates drugs for two categories of diseases: where the cause of the disease is well-defined and where are no approved therapies, or there are significant shortcomings with existing treatment paradigms.



To generate its datasets Recursion Pharmaceuticals is primarily focused on:

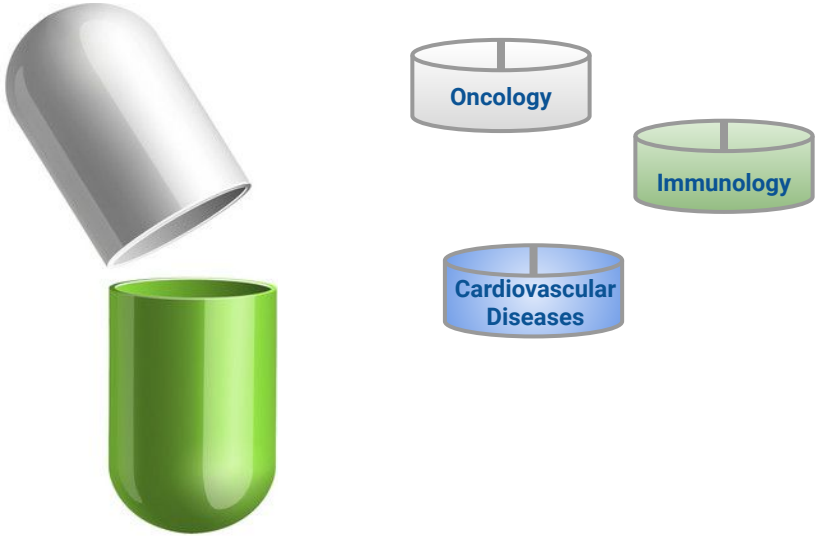
- **Advanced biotechnology tools** such as CRISPR genome editing and synthetic biology
- **Reliable automation** of complex laboratory research at unprecedented scale using advanced robotics
- **Iterative analysis** of, and inference from, large, complex in-house datasets using neural network architectures
- **Increasing elasticity** of high performance computation using cloud solutions



Most Innovative R&D Approaches of AI in Biopharma. OWKIN

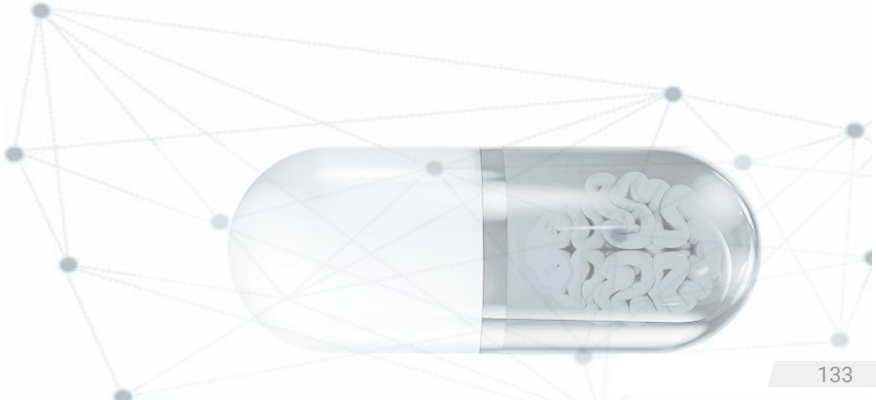
Owkin is a predictive analytics company that was founded based on the belief that medical research must be collaborative, inclusive and protect privacy. Today, Owkin is building a global research network leveraging federated learning that brings data scientists, physicians, researchers and pharmaceutical companies representatives together on a research platform that ensures data security and privacy. Owkin is developing AI tools for medical researches to give patients access to safer and more effective therapies.

Main focus areas:



The way AI is used:

- to investigate the mechanisms which cause a different drug efficacy from patient to patient
- to enhance the drug development process
- to identify the best personalized drug candidates for the patient to improve treatment outcomes



How Owkin Uses AI in R&D?

Owkin has created a unique research platform, and a portfolio of AI models and solutions.

The Owkin Loop is the heart of the Owkin Research Platform: it connects medical researchers with high-quality datasets from leading academic research centers around the globe. Owkin Loop is powered by the two main components of Owkin's Software Stack: Owkin Studio, their machine learning platform, and Owkin Connect, their federated learning framework.

Owkin AI models

Owkin created a catalog of 30 live diseases models and has 40 additional models in the pipeline.These models differ from traditional black box models because they are built using interpreted AI, which allows the company to move further in research and identify biomarkers responsible for predictions. The discovery of new multimodal biomarkers is essential to identify new biological targets, optimize the design of clinical trials using patients subgroups, and identify patients eligible for a particular treatments.

Data Enrichment Models

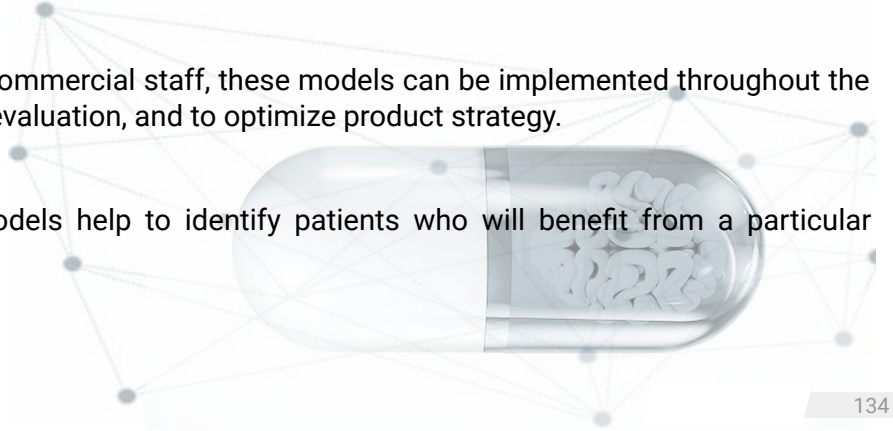
Designed for translational researchers and pathologists, these models link histology to molecular markers.

Outcome Prediction Models

Designed for translational researchers, development executives, and commercial staff, these models can be implemented throughout the clinical drug development process to improve clinical trial design and evaluation, and to optimize product strategy.

Patient Identification Models

Designed for commercial and precision medicine leaders, these models help to identify patients who will benefit from a particular treatment.

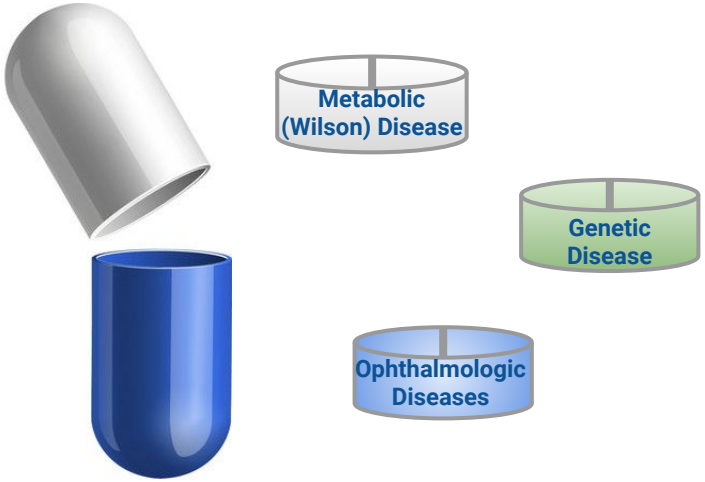


Most Innovative R&D Approaches of AI in Biopharma. Deep Genomics

Deep Genomics uses artificial intelligence to build a new genetic therapy. They create steric blocking oligonucleotides. It is a short stretch of special DNA or RNA that attaches to a specific place in the RNA. By doing so, they modify the translation process. They do not integrate into the genome and do not make any permanent changes to the DNA.

The Workbench of Deep Genomics mines RNA biology data, processes it, identifies novel targets, and evaluates thousands of possibilities to identify the best therapeutic candidates.

Main focus areas:



The way AI is used:

- target discovery: they examine all the possibilities and identify disease-causing mutations and ways of fixing the genetic problem
- therapy design: the AI assesses hundreds of thousands to millions of different potential targeted therapies to find the ones that are most likely the best. These are then verified in the wet-lab
- to produce On-target and genome-wide off-target effect data, cell viability data and animal toxicity data



How Deep Genomics Uses AI in R&D?

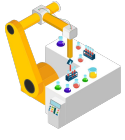
Deep Genomics use its AI Workbench to discover and develop genetic therapies with an increasing success rate.



Genetic Medicines. Deep Genomics' AI Workbench enables them to efficiently find drugs with desired properties. The company is focussing on the development and marketing of antisense oligonucleotide therapy that target the disrupted genes. Deep Genomics is predicting altered molecular phenotypes, such as changes in gene expression, impaired splicing, and protein truncation that may caused genetic diseases.



The **Deep Genomics platform** is able to produce On-target and genome-wide off-target effect data, cell viability data and animal toxicity data for every compound. They also collect data related to biomarkers. All data is processed using feedback loops.



The **Deep Genomics' research works** have appeared in Science, Nature, Nature Genetics, Nature Medicine, Nature Methods, Proceedings of the IEEE, NIPS, Bioinformatics, RECOMB and ISMB.

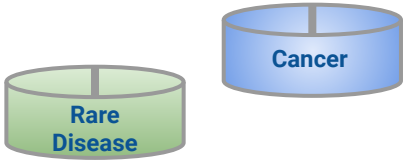
Project Saturn has proved the utility of Deep Genomics' AI platform

In Project Saturn, the Deep Genomics team used their platform to evaluate over 69 billion oligonucleotide molecules against 1 million targets *in silico*, to generate a library of 1000 compounds that were experimentally verified to manipulate cell biology.

Most Innovative R&D Approaches of AI in Biopharma. AI Therapeutics

AI Therapeutics using AI to accelerates drug development by integrating deep learning algorithms to the biological data. It includes next-generation sequencing, chemical genomics, and screening of drug combinations to match drugs to targeted diseases.

Main focus areas:





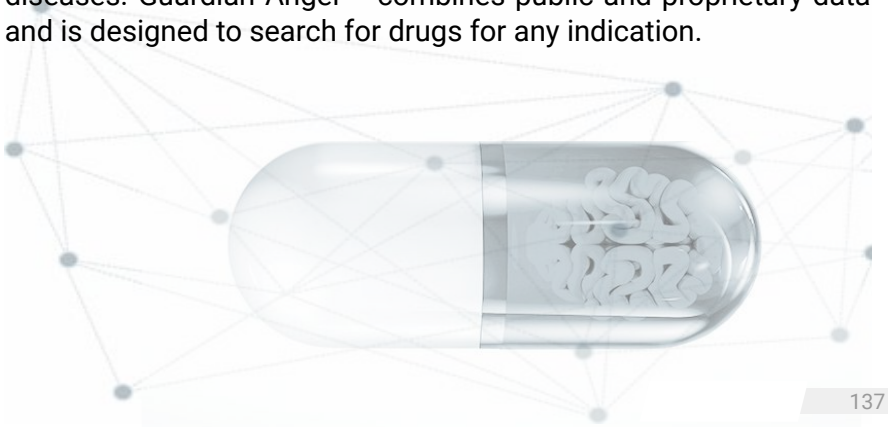
Drugs currently in **clinical trials** target:

- Lymphangioleiomyomatosis
- B-cell non-Hodgkin lymphoma
- acute myeloid leukemia
- amyotrophic lateral sclerosis
- facial angiofibroma
- COVID-19

The way AI is used:

- to precisely match drugs to diseases
- to identify the best personalized care for each patient

AI Therapeutics has developed a new Guardian Angel™ artificial intelligence algorithm that has learned to predict new therapies for diseases. Guardian Angel ™ combines public and proprietary data and is designed to search for drugs for any indication.



Industry Developments 2019-2021



DEEP
PHARMA
INTELLIGENCE

Investment Landscape at a Glance (Q1-Q2 2021)

The total amount of VC funding in AI-biotech startups increased during the first half of 2021 approaching a total of **$2.93B**.

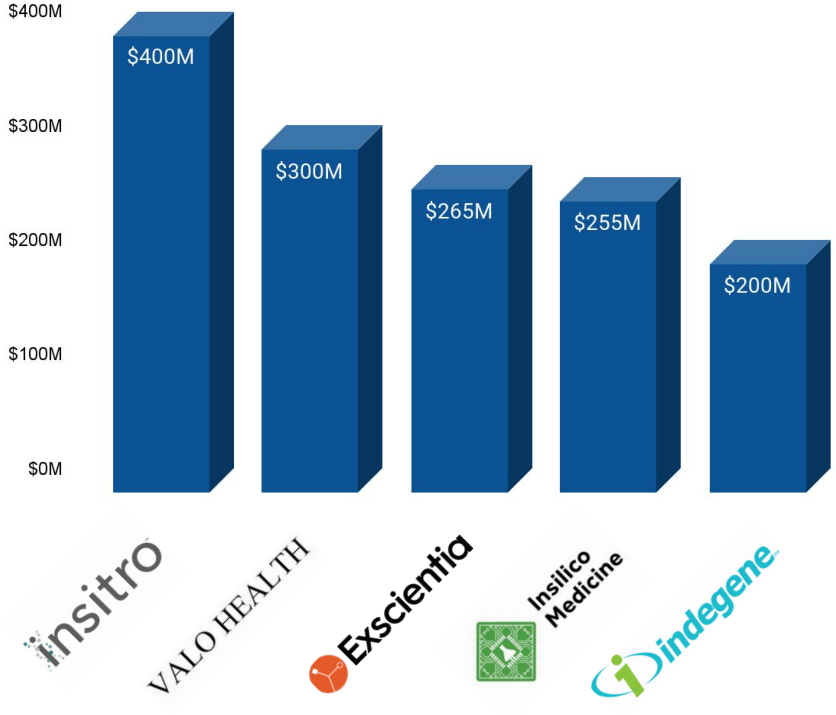
There is an increasing number of late-stage mega-rounds including hundreds of millions. The apparent trend is sector consolidation, where a number of AI-startups have achieved substantial leadership and grown in resources and technology.

Some of the major deals included:

- **Insitro** with $400 million (Series C)
- **Valo Health** with the sum of $300M (Series A&B)
- **Exscientia** with $265 million (series D)
- **Insilico Medicine** with $255 million (Series C)
- **Indegene** with the sum of $200 million (Private Equity Round)

An important driver of growth for the sector is a substantial shift in Big Pharma's interest in AI technology from "nice to try" to "strategically important". Such increasing market demand will drive more exits in future, and is important for heating up the investor's interest in this sector.

Top-5 Investment Deals in Q1-Q2 2021



Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

NOV 2019

- AI start-up, **Deep 6**, secured $17M from **Point72 Ventures** to accelerate patient recruitment. According to the Forbes, the Deep 6's AI-powered platform is valued at $50M and is able to find patient for the clinical trial in minutes, whereas this process usually takes months. Deep6 applies natural language processing to extract data from electronic medical records, pathology reports, physicians notes, and other documentation.
- **AstraZeneca** intends to open AI and drug research centers in China and make a $1B capital infusion into Chinese biotech innovations. The global R&D center will be opened in Shanghai, where research will be focused on diseases prevalent in China. China is already the second market for AstraZeneca after the United States, and sales in China continue to grow.

DEC 2019

- **Page** raised $45M to accelerate cancer research. The round was led by **Healthcare Venture Partners**, with the participation of previous investor **Breyer Capital**, **Kenan Turnacioglu**, and others. Page's artificial intelligence technology for mapping cancer pathology was developed by Dr. Thomas Fuchs, also known as the "father of computational biology." The company also has access to the repository of 25 million pathology slides owned by the Memorial Sloan Kettering Cancer Center, which is the perfect material to feed the AI engine.

JAN 2020

- **Exscientia** has entered a 3-year $266 million agreement with Bayer. The partnership will leverage AI to accelerate the discovery of small molecules candidates programs for oncology and cardiovascular diseases.
- The first drug developed using artificial intelligence by **Exscientia** in partnership with **Sumitomo Dainippon Pharma** is entering Phase I clinical trial for the treatment of the obsessive-compulsive disorder. The drug, called DSP-1181, was discovered using Exscientia proprietary Centaur Chemist technology. The clinical trials will start in Japan, and Sumitomo Dainippon Pharma will add DSP-1181 to its psychiatry and neurology pipeline.
- **Deep Genomics**, a Toronto-based start-up, raised $40M in Series B funding round. The round was led by **Future Ventures** with the participation of **Amplitude Ventures**, **Khosla Ventures**, **Magnetic Ventures**, and **True Ventures**. The Deep Genomics software, Saturn, is used to identify and better understand drug targets, especially ones that are thought to be undruggable. The company hopes two programs will be advanced to the IND application in 2020.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

FEB 2020

- **Schrödinger** enters a 5-year agreement with **Bayer** to work on a new virtual platform for small molecules design, which will be able to design and screen synthetically feasible compounds. The collaboration will be built on Schrödinger's machine learning and molecular design technologies, while Bayer will provide in silico model for predicting the pharmacological properties of the molecules.
- **Insilico** will work with **Pfizer** to collect real-world-data for targets in multiple therapeutic areas.
- **Schrödinger**, a chemical software company, raised $232M in IPO. Several drug candidates that are currently developing by the pharmaceutical companies were discovered using Schrödinger's software. In the future, the company will focus on the expanding of its software applications and bringing up new customers. The company is also developing its own pipeline for oncological indications.
- Scientists from **MIT** discovered one the most powerful antibiotic known to date using Artificial Intelligence. The algorithm was trained on 2500 existing antibiotics and was able to screen more than one hundred million molecules in several days. This is an absolute breakthrough in antibiotic discovery, the area that is now facing the problem of multi-resistance of bacteria strains. The new antibiotic, called halicin, was able to kill 35 types of potentially deadly bacteria.
- **Lunit**, a Korean start-up, has raised $26M in its series C funding led by Korea's **Shinhan Investment**, followed by **InterVest**, **IMM Investment**, **Kakao Ventures**, and China's **Legend Capital** of Lenovo Group. With the new funding, Lunit plans to increase the global sales of its AI products — Lunit INSIGHT CXR for analyzing chest X-rays images and Lunit INSIGHT MMG for mammography. Additionally, the fund will support the development of the AI tool for analyzing cancer pathological tissue slides — Lunit SCOPE.
- **BenchSci** raised $22M in financial round B, bringing the company to $45M of total funding. Besides raising a new round, the company announced the launch of its new AI-powered reagent selection product and the expansion of the agreement with **Novartis**. Another BenchSci's product, AI-Assisted Antibody Selection, uses AI to search for data on published antibodies and can select antibodies in 30 seconds instead of 12 weeks. The fund will help BenchSci to develop its products and accelerate drug testing.
- **Qure.ai** has secured $16M from **Sequoia Capital India** and Singapore-based **MassMutual Ventures Southeast Asia**. Qure.ai is artificial intelligence provider of automated interpretation of radiology images: X-rays, CTs, and MRI scans.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

MAR 2020

- **Atomwise** enters into a research collaboration with a Korean clinical-stage biotech **Bridge Biotherapeutics**. Atomwise will apply structure-based AI technology to evaluate and initiate programs for Pellino E3 ubiquitin ligases and other targets.
- **Alibaba Cloud** launched a series of AI solutions to help fight the coronavirus infection. The three of them are available for free for research institutes and medical specialists worldwide. The solutions were created by the joint work of **Alibaba Cloud**, **Alibaba DAMO Academy**, and **DingTalk**. These include Epidemic Prediction Solution, CT Image Analytics Solution, Genome Sequencing for Coronavirus Diagnostic Solution, and Elastic High-Performance Computing (E-HPC) Solution for Life Sciences. The last was built especially for Computational and AI-driven drug discovery, as well as for other life science applications, and has been applying by 20 research groups in China.
- **Schrödinger** enters a 3-year collaboration with **Google Cloud** to leverage the supercomputer power for speeding up Schrödinger's molecular modeling platform. Schrödinger has ambitious plans to hire thousands of professors to be able to run simulations for billion compounds per week. The agreement is following Schrödinger's IPO last month, where the company raised $232 million. The purpose of this collaboration is targeting DNA damage response pathways and related cancers with small molecules. The company has plans to start IND-enabling, preclinical studies in 2021.
- **Reverie Labs** enters a multi-target partnership with **Roche** to discover next-generation kinase inhibitors. The company will apply its expertise to screen, generate hits, and perform hit-to-lead optimization together with scientists at Roche and **Genentech**. The kinases are perfect objects to drain ML models, as there is a lot of published data about them.

APR 2020

- **BenevolentAI** predicted the repurposed drug for treating coronavirus, that entered Phase III clinical trials. This drug, called Baricitinib, was developed by **Eli Lilly** and **Incyte** and approved for the treatment of rheumatoid arthritis under the "Olumiant" name. Benevolent claims that it took only 1,5 hours to run it's AI algorithms and 3 days of manual work to predict this molecule.
- **Insilico** collaborates with **Boehringer Ingelheim** to help to discover new targets within the Boehringer's Research Beyond Borders initiative, created to expand areas and the geographies of the company's drug discovery collaborations. Insilico will provide its generative models and machine learning programs and give access to its new Pandomic platform to facilitate visualization of omics data connected to signaling pathways and disease profiling.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

MAY 2020

- **Insitro**, a machine learning-driven drug discovery company, raised $143M in Series B financing. The round was led by **Andreessen Horowitz**, with the participation of the **Canada Pension Plan Investment Board** (CPP Investments) and other funds. The investment will be used to further develop the company's technology and automation, which allows the in-house generation of a massive amount of biological data to train algorithms and built predictive disease models. The company also plans to advanced biomarker development and personalized therapeutics.
- **AbCellera** received $105M Series B Financing from **OrbiMed**, **DCVC Bio**, and an investor syndicate that includes **Viking Global Investors**, **Peter Thiel**, **Founders Fund**, **Eli Lilly**, **University of Minnesota**, and **Presight Capital**. By applying AI, AbCellera is transforming the area of antibody discovery. The investments will be used to improve and expand their technology creating new tools and to develop new therapeutic modalities. AbCellera successfully developed 55 drug candidates, including targeting GPCRs and ion channels.
- **Exscientia** has raised $60M in financial round C. The round was led by **Novo Holdings**, **Evotec**, **Bristol Myers Squibb**, and **GT Healthcare Capital**. Proceeds will be used to expand the company's drug discovery pipeline and to built "full-stack" capabilities. Additionally, Exscientia plans to expand its presence to the USA market. The company is also involved in the coronavirus pandemic fight, as it partnered with **Calibr** and **Diamond Light Source** to develop an anti-Sars-Cov-2 treatment.
- **Boehringer Ingelheim** partners with **BERG** to investigate inflammatory diseases, particularly inflammatory bowel disease and Crohn's disease, find the causes, develop new biomarkers, targets, and new drugs. BERG CEO Niven Narain emphasizes that it is a biology company that has wet lab facilities for data generation, applies a mathematical approach distinct from machine learning, and has 2 drugs in companies portfolio that have been advanced to the clinic.
- **Immunai** has raised $20M in a seed round from **Viola Group** and **TLV Partners** to map the entire immune system. The startup combines machine-learning and single-cell technologies to map immune cells and their functions. The technology was developed to profile immune cells from blood samples, support biomarker discovery, and investigate the cellular response to the cancer immunotherapies. This research will help to improve immunotherapies, as even a slight variation in immunotherapies can bring to dramatically different patient responses.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

JUNE 2020

- **Owkin** raised $18M in Series A financing. The investment was made by **Mubadala Capital** and **Bpifrance**, through the bank's **Large Venture** fund. The company will continue to develop its platform aimed to make the drug discovery process more collaborative. The platform utilizes imaging, genomic, and clinical data and connects researchers from industry and academia, clinicians, and other players.
- **Cyclica** secured $17M in financing round B from **Drive Capital** with the participation of **Chiesi Farmaceutici**, **GreenSky Capital**, and members of Cyclica's management team. This Toronto-based start-up developed two platforms — Ligand Design and Ligand Express that predict molecular properties via applying deep learning technology.
- **Google** partners with a fresh start-up, **ZebiAI**, to launch Chemome initiative. Previously, Google and X-Chem demonstrated a new approach for finding biologically active compounds — a combination of DNA encoded libraries screening technology and virtual screening using a graph convolutional neural network developed by Google.

JULY 2020

- **Yale School of Medicine** and **AI therapeutics** launched Phase II clinical trials of a new anti-Sars-Cov-2 drug "LAM-002A". The drug, also called apilimod, has been shown to prevent the virus from entering cells. Previously LAM-002A proved safety for the treatment of lymphoma and autoimmune diseases, and it is being repurposed for coronavirus treatment after AI Therapeutics screened about 13,000 existing drugs against two strains of Sars-Cov-2. The study results were published in Nature.
- **Lantern Pharma** announced an agreement with leading contract manufacturing companies to prepare for the start of Phase II and Phase I clinical trials of its two anti-cancer drug candidates. The first candidate - LP-300, that was developed against non-small cell lung cancer among never-smoker, is entering the Phase II clinical trial stage. The second candidate, LP-184, developed to treat a specific type of solid tumor and glioblastoma multiforme, is anticipated to enter Phase I stage at the end of 2021 or in early 2022. Latent hopes that annual sales of this drug will be accounted for $3.5 billion USD by 2025. Both drug candidates were created using RADR® A.I. platform, which combines ML methods, genomics, and computational biology to unveil drugs MoA and discover biomarkers for precision oncology.
- Global Open Science project **COVID Moonshot** was launched by the international consortium of industrial and academic partners, including AI-driven startup **PostEra**. The goal of this initiative is to create novel anti-COVID drugs, including attempts to block SARS-Cov-2 main protease. The project is managed by PostEra, the start-up that applies AI to prioritize ideas and find optimal synthesis routes.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

AUG 2020

- **Atomwise** raised $123M in a round B of financing led by **B Capital Group** and **Sanabil Investments**, also including **DCVC**, **BV**, **Tencent**, **Y Combinator**, **Dolby Family Ventures**, **AME Cloud Ventures**, and 2 top insurance companies. The investment will be used to start the company's own drug discovery pipeline, extend the market, and develop new partnerships with pharmaceutical companies.
- **IBM** introduced a new cloud platform — **RoboRXN**, which is a free AI-enabled chemical service for the prediction of molecule interactions and the discovery of new drugs. The platform will be primarily used to discover compounds against coronavirus proteins. RoboRXN combines artificial intelligence, cloud technologies, and automation for organic chemistry. Additionally, new organic reactions might be discovered using the platform. The platform can work remotely and analyze commands copied from literature by chemists.

SEP 2020

- Chinese tech giant **Baidu** plots an AI-baked drug discovery startup, looking for investors to collectively infuse $2B in. The start-up is planned to be a standalone company, but not Baidu's subsidiary. Baidu has previously invested in other AI startups — Atomwise, Insilico, and Polaris Biology.
- **XtalPi**, a Chinese pharmaceutical tech company, has raised $319M in funding round C, which was led by **SoftBank Vision Fund 2**, **PICC Capital**, and Chinese firm **MorningSide Venture Capital**. The funding will be used for the further development of XtalPi's Intelligent Digital Drug Discovery and Development (ID4) platform, which combines artificial intelligence, quantum mechanics, and high-performance cloud computing algorithms to predict activities of small molecule drug candidates, solid-form selection, and other critical aspects of drug development.
- **Recursion Pharmaceuticals** raises $239M in series D funding round. This includes $50M from **Bayer**'s investment arm **Leaps** and funds from **Casdin Capital**, **Baillie Gifford**, and others. Recursion has also entered in drug discovery collaboration with Bayer to develop new treatments against fibrotic diseases of different organs. Recursion will receive $30M of upfront payment and could potentially receive $100M milestones for each discovery program and royalties on future sales.
- The **MELODY (Machine Learning Ledger Orchestration for Drug Discovery) project** initiated by 10 major pharmaceutical companies achieved its first goal — the deploying of a drug discovery platform. Together with **Nvidia** and **Owkin**, these companies are building the federated learning solution where AI can be trained on desperate datasets from different sites without the need to collect data together.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

SEP 2020

- **Exscientia** teams up with **Huadong Medicine** for the small molecules oncology program. The project is focused on DNA damage repair and specifically investigates the transcription control of DNA damage response genes, which disruption leads to the mutation accumulations. Both companies will share the responsibilities for the project.
- **Insilico Medicine** is launching a new target and drug discovery platform Pandomics, that is the part of the **Pharma.ai**. The platform enables to analyse and interpret OMICS data without having an experience in bioinformatics and computational biology. The technology has been developing for 6 years, and proved itself in several collaborations and Insilico's own drug development programs.

OCT 2020

- **Taisho Pharmaceutical** and **Insilico** have entered into a research collaboration to identify novel therapeutics against aging. Insilico Medicine will utilize both the target discovery and generative chemistry parts of its Pharma.AI platform in this collaboration. It will use its proprietary Pandomics Discovery Platform to identify novel targets for senolytic drugs and Chemistry42 platform for a molecular generation.
- **Nvidia** has entered into a partnership with **GlaxoSmithKline (GSK)** and its artificial intelligence (AI) group for the discovery of drugs and vaccines. The joint lab will uses biomedical data, AI approaches and advanced computing platforms to obtain genetic and clinical data with accuracy and scale.

NOV 2020

- **Schrödinger**, Inc. has announced a discovery collaboration with **Bristol Myers Squibb Company** to discover, develop, and commercialize therapeutics in multiple disease areas. Under the agreement, Bristol Myers Squibb will pay Schrödinger $55 million upfront, and Schrödinger will also be eligible to receive up to $2.7 billion in preclinical, development, regulatory and sales-based milestone payments. Additionally, Schrödinger is entitled to receive royalties on net sales of each product commercialized by Bristol Myers Squibb.
- **BioMarin** and **Deep Genomics** have announced partnership on AI rare disease drug discovery. The parties will leverage Deep Genomics' AI drug discovery platform, the AI Workbench, to identify and validate target mechanisms and lead candidates, while BioMarin will be responsible for pre-clinical and clinical development.
- **Insilico Medicine** has announced that it has entered into a multi-target drug discovery agreement with **Janssen Pharmaceutical N.V.** Insilico Medicine will design small-molecule hits with the defined properties for several targets nominated by Janssen. Insilico Medicine will demonstrate the discovery process and detailed platform capabilities.

Selected Pharma AI Industry Developments Q4 2019 — Q1 2021

NOV 2020

- **ConcertAI** announced a multi-year collaboration with **Novartis** to advance research-grade real-world data (RWD) and advanced analytic technologies to support decision-making across the full scope of the Novartis' oncology pipeline and portfolio. The partners defined characteristics of RWD that extend the insights traditionally gleaned from this source, bridging the space between traditional RWD and randomized controlled trials (RCT) by increasing RWD consistency, reliability, and veracity.
- **Owkin**, a startup that deploys AI to augment medical research, accelerate drug development and enable scientific discoveries, announced a partnership with **the Institut Pasteur**, a private, non-profit foundation whose mission is to help prevent and treat diseases, mainly those of infectious origin. This partnership will focus on developing a new machine learning model capable of identifying COVID-19, and any coronaviruses, protein sequences (as known as epitopes) with high immunogenic potential that could be used for peptide-based future vaccines.
- **BioNTech SE** and **InstaDeep Ltd** announced a multi-year strategic collaboration aimed at applying the latest advances in AI&ML to develop novel immunotherapies for a range of cancers and infectious diseases. The companies have formed a joint AI Innovation Lab in London, UK, and Mainz, Germany, to advance a portfolio of initiatives across drug discovery and design, protein engineering, manufacturing and supply chain optimization.

DEC 2020

- **Immunai,** a company specializing in comprehensive mapping of the human immune system, has joined forces with **10x Genomics**. The latter was aimed at leveraging its single-cell technologies to map hundreds of cell types and states. By applying its artificial intelligence (AI) and machine learning (ML) algorithms, Immunai supports biomarker discovery and insight generation to help power new therapeutic discoveries and accelerate drug development.
- **Insilico** partnered with **APRINOIA** on AI-powered neurodegenerative drug discovery. The partnership was aimed at utilizing Insilico's novel generative artificial intelligence (AI) technology to accelerate the discovery of next generation compounds targeting abnormal proteins in brain associated with neurodegenerative diseases.
- **Optibrium, Intellegens** and **Medicines Discovery Catapult (MDC)** has announced the collaboration to demonstrate how their software supports drug discovery teams in identifying compounds with improved 'on target' properties more efficiently in case studies with pharma and biotech companies. Alchemite™ technology from Intellegens was validated on drug discovery applications and integrated into a robust, deployable platform, Cerella™.

Selected Pharma AI Industry Developments Q4 2019 - 2021

JAN 2021

- **Boehringer Ingelheim** announced a collaborative agreement with **Google Quantum AI (Google)**, focusing on researching and implementing cutting-edge use cases for quantum computing in pharmaceutical research and development (R&D), specifically including molecular dynamics simulations. The new partnership combines Boehringer Ingelheim's leading expertise in the field of computer-aided drug design and in silico modeling with Google's outstanding resources as one of the leading developers of quantum computers and algorithms.
- **Nucleai**, a global provider in pathology-based biomarker discovery, and **Debiopharm**, a Swiss-based biopharmaceutical company specializing in drug development, announced that they have entered into a long-term collaboration to leverage Nucleai's artificial intelligence (AI) -powered biomarker research & discovery platform for one of Debiopharm's clinical stage oncology assets.
- **The Abdul Latif Jameel Clinic for Machine Learning in Health** ("Jameel Clinic") at MIT, a Cambridge, Mass.-based scientific research institute that harnesses the power of new technologies to transform healthcare, announced a long-term strategic collaboration with **Sanofi**, a multinational diversified healthcare company. The Jameel Clinic and Sanofi pharmaceutical research teams will collaborate on the development and application of artificial intelligence (AI) and machine learning capabilities to revolutionize healthcare and advance impactful and effective drug discovery and development. The collaboration will provide Sanofi with access to more than 50 principal investigators and researchers across MIT.
- **BenevolentAI** announced that the biopharmaceutical company **AstraZeneca** has selected a novel chronic kidney disease (CKD) target to advance to its drug development portfolio, making it the first AI-generated target from the collaboration to enter the Company's portfolio. The Benevolent Platform® predicted this novel target, which was subsequently biologically validated through AstraZeneca's rigorous experimental testing.

FEB 2021

- Pharma giant **AstraZeneca** announced a collaborative agreement with **AliveCor**, maker of artificial intelligence-enabled personal ECG devices, in an effort to study new ways of managing cardio, renal and metabolic issues. The partnership will revolve around AliveCor's Kardia-K AI, which is designed to analyze ECGs in order to measure a patient's potassium levels without needing to draw blood from the patient. Specifically, the collaboration will zero in on how this technology can be used in real-world disease management and applications.

Selected Pharma AI Industry Developments Q4 2019 - 2021

MAR 2021

- **Iktos** announced the application of Iktos Artificial Intelligence technology for de novo design to selected **Pfizer** small-molecule discovery programs. A key aspect of the technology is that exploration of chemical space is performed by generating compounds in silico under the constraints of program endpoints, rather than screening libraries of compounds.
- **insitro** has raised $400M in a Series C financing. The financing was led by Canada Pension Plan Investment Board (CPP Investments), with significant participation from current investors Andreessen Horowitz, funds and accounts advised by T. Rowe Price Associates, Inc., Casdin Capital, and funds and accounts managed by BlackRock.
- Biotechnology company **Antiverse** has raised £1.4M in seed funding to further develop its artificial intelligence (AI) antibody drug discovery platform which is focused on identifying new therapeutics for cancer, heart and lung diseases.
- **Amgen** announced that it has entered into a multi-year partnership with **Mila** – Quebec Artificial Intelligence Institute. This new partnership will permit Amgen to expand its knowledge of AI and deep learning by interacting and engaging with experts in Mila's unique ecosystem, both virtually and (eventually) on the Mila campus in Montreal.

APR 2021

- **NVIDIA** and **AstraZeneca** revealed a new drug-discovery model called MegaMolBART, which is aimed at "reaction prediction, molecular optimization and de novo molecular generation." MegaMolBART will be deployable on NVIDIA's platform for computational drug discovery, known as Clara Discovery, and will use a new kind of technology called transformer neural networks.
- **NVIDIA** announced a strategic partnership with **Schrödinger** that harnesses NVIDIA DGX A100™ systems to further expand the speed and accuracy of Schrödinger's computational drug discovery platform and enable rapid, accurate evaluation of billions of molecules for potential development of therapeutics. The companies will optimize Schrödinger's software platform — designed to model and predict the properties of novel molecules — for the NVIDIA DGX SuperPOD™, which is built with NVIDIA DGX A100 systems and NVIDIA InfiniBand HDR networking.
- **Exscientia** has closed on a $525M funding round, with the proceeds going toward advancing its pipeline through clinical trials and extending its technology platform for autonomous drug design. SoftBank Vision Fund 2 led a $225M Series D round for Exscientia and has agreed to contribute $300M in equity, which the company will use at its discretion.

Selected Pharma AI Industry Developments Q4 2019 - 2021

APR 2021

- **Medable Inc**. has obtained $78M in new capital to accelerate the industry's transformation to patient-centered medication development by advancing the delivery of digital and decentralized clinical trials. Sapphire Ventures led the round, which included new investor Obvious Ventures as well as follow-on fundraising from current investors GSR Ventures, PPD, Inc., and Streamlined Ventures.
- **StoneWise**, a Chinese medtech business that develops medications using artificial intelligence (AI), has completed its series B and series B+ investment rounds, raising a total of $10M. The financing rounds coincide with the Covid-19 pandemic, which emphasizes the importance of AI and other cutting-edge technology in disease diagnosis and treatment.
- **PharmCADD**, a drug discovery firm based on artificial intelligence and physics in Busan, South Korea, has raised $16B in Series B funding. The money will be used to open offices in the United States and India, as well as to enhance the company's AI & Physics-based drug discovery platform technology, PharmulatorTM, grow R&D workforce, and perform preclinical studies on internal pipelines.

MAY 2021

- **Lantern Pharma**, a clinical stage biopharmaceutical company using its proprietary RADR® artificial intelligence ("A.I.") platform to transform the cost, pace, and timeline of oncology drug discovery and development, has entered into a research and development collaboration with **Actuate Therapeutics**. The collaboration will focus on leveraging the RADR® machine learning technology, large-scale oncology datasets, and the A.I. platform to accelerate key aspects of Actuate's 9-ING-41 drug candidate, a best-in-class GSK-3β inhibitor in active development in multiple Phase 2 clinical trials, including for pancreatic cancer.
- **Bristol-Myers Squibb** has agreed to pay up to $1.2B to enter a drug discovery collaboration with artificial intelligence start-up **Exscientia** as the Big Pharma company bets on the power of the technology to turbocharge drug development. The agreement comes as the biotech industry deploys AI to speed up the process of screening molecules that can then be tested as drugs to tackle illnesses ranging from cancer to heart disease.
- Israeli company **CytoReason** announced a partnership with Swiss multinational, **Ferring Pharmaceuticals**, to establish new treatments for inflammatory bowel disease (IBD). CytoReason is developing a computational model of the human body, which has the potential to help Ferring accelerate drug discovery while reducing costs. Leveraging a library of both public and proprietary molecular data, CytoReason's technology allows scientists to gain critical information on the body's functioning, and address diseases such as IBD at the cellular level.

Selected Pharma AI Industry Developments Q4 2019 - 2021

MAY 2021

- **Aetion**, a health-care technology business, announced a $110M Series C fundraise led by **Warburg Pincus**, a major global growth equity firm, with participation from B Capital and Foresite Capital. New Enterprise Associates (NEA) and Flare Capital Partners, two of Aetion's previous investors, also participated in the round.
- **eTherapeutics**, a Newcastle-based pharmaceuticals company, has successfully placed shares on the stock market, raising another £22.5M. The drug business said it would utilize the new funds to help fund a range of activities, with a particular focus on growing its patented, disease-agnostic drug discovery and development platform.
- **PathAI** has raised $165M in a recently completed Series C round. **D1 Capital Partners** and **Kaiser Permanente** co-led the funding. Another dozen investors, including Bristol-Myers Squibb, Labcorp, and Merck's Global Health Innovation Fund, participated in the round. The funds will expand the PathAI product suite and commercial footprint to enhance the full lifecycle of the drug development process from translational and exploratory research to global commercialization.
- **AcuraStem**, a patient-based drug discovery platform company developing novel therapeutics for amyotrophic lateral sclerosis (ALS) and neurodegenerative diseases, has received an ALS Research Program Therapeutic Development Award from the Department of Defense, Congressionally Directed Medical Research Programs totaling $1 million.
- **Iktos** announced a Research Collaboration Agreement with **Kadmon**, pursuant to which, Iktos's generative modelling artificial intelligence (AI) technology will be used to enable the rapid and cost-effective design of novel drug candidates for an undisclosed Kadmon drug discovery program. Under the agreement, Iktos will use its de novo structure-based generative modelling technology to identify novel compounds that match a pre-defined target product profile, with the aim of expediting Kadmon's early phase discovery efforts.
- **Engine Biosciences**, a biotech based in Singapore and San Carlos, California that deciphers complex biology to develop pharmaceuticals, has raised $43M in a Series A investment round. The money will be used to grow the company's precision cancer treatments portfolio, prepare for its first clinical trials, and scale its patented technology platform.

Selected Pharma AI Industry Developments Q4 2019 - 2021

MAY 2021

- **Causaly**, London's AI/machine learning platform that connects all the dots in a flash, raised $17M in a Series A investment headed by **Index Ventures**. Marathon, Pentech, and the EBRD were also present. The new financing will be used to expand the company's technical and sales teams in order to reach the American market.
- **Molecule.one**, a Polish computational chemistry firm, has acquired $ 4.6M to continue its quest to develop theoretical medicinal compounds. Its machine learning methods anticipate the optimal ways to manufacture potentially valuable compounds, which is a critical step in developing new medications and therapies.

JUNE 2021

- **Mendel**, a clinical AI platform based in San Jose, that reads unstructured, natural language material in medical papers, has secured $18 million in Series A funding. The funds will be used to expand the company's business and team in sales, business development, communications, and human resources in its San Jose and Cairo, Egypt locations by 4X by Q1 2022.
- **Insilico Medicine**, a global leader in end-to-end artificial intelligence for target discovery, small molecule chemistry, and clinical development, has raised $255M in a Series C round led by **Warburg Pincus**. The funds will be used to advance Insilico Medicine's current therapeutic programs into human clinical trials, launch a number of new studies for innovative and difficult targets, and improve its AI and drug discovery capabilities.
- **Strateos**, a California-based business that specializes in development remote access laboratories and lab control software for life science research, has received $56.1M in Series B funding. **DCVC** and **Lux Capital** led the investment, with Eli Lilly and Company, Ally Bridge Group, Black Diamond Ventures, Mack & Co., LLC, and Castor Ventures joining as new investors.
- **xCures Inc.**, an innovator in the patient-centric use of artificial intelligence and predictive modeling, announced that it has earned $12.69M in Series A funding. This investment, which was headed by **Boehringer Ingelheim Venture Fund** and included Vanedge Capital, Harmonix Fund, and Metaplanet, will be utilized to accelerate the adoption and development of xCures' AI-Powered platform for precision oncology decision making.

Selected Pharma AI Industry Developments Q4 2019 - 2021

JUNE 2021

- **Antidote Technologies**, a digital health enterprise running in the United States and the United Kingdom, has raised $23M in funding. **LBO France** led the round with a $10M investment through its Digital Health 2 fund, with existing investors Merck Global Health Innovation Fund, Smedvig Capital, and Octopus Ventures contributing a total of $13.2M.
- Swiss pharma company **Novartis** has announced a collaboration with **Hewlett Packard Enterprise (HPE)** to accelerate its use of data and digital technologies. Novartis, through its collaboration with HPE, is aiming to identify and integrate diverse data sources to enable real-time disease insights to inform 'targeted response strategies'.
- **CytoReason**, an AI company, announced the initiation of a project with French global biopharmaceutical company **Sanofi**. The focus of this project is to gain clarity on the heterogeneity of asthma patients, with the goal of identifying stable and reproducible asthma endotypes, as well as associated diagnostic features, using minimal invasive procedures.
- **Nucleai** and **Merck KGaA, Darmstadt, Germany** have entered into a long-term collaboration to leverage Nucleai's image analysis and biomarker discovery platform for several Merck KGaA, clinical-stage oncology assets. As part of the collaboration, Merck KGaA, Darmstadt, Germany will leverage Nucleai's platform for exploratory research, with the potential to further develop identified pathology-based biomarkers as companion diagnostics.
- **Recursion**, a clinical-stage biotechnology company decoding biology by integrating technological innovations across biology, chemistry, automation, machine learning and engineering, today announced a multi-year collaboration with **Mila**, the Quebec Artificial Intelligence Institute, to accelerate Recursion's machine learning capabilities. Recursion will open office space within Mila and build a team focused on using machine learning for tech-enabled drug discovery.

JULY 2021

- **Sosei Group Corporation** and **InveniAI® LLC** announced the initiation of a new R&D collaboration. The objective of the collaboration is to identify new therapeutic product concepts for immune diseases where an AI- and ML-based approach can be applied to generate compelling evidence for the role of G-protein coupled receptors (GPCRs) in relevant immunomodulatory pathways; the goal being to use these targets as a basis for SBDD to generate novel compounds that could improve responses to existing immunotherapies.

Key Takeaways



DEEP
PHARMA
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Major Observations for Q1-Q2 2021: Key Business Takeaways

1. **The segment of pharmaceutical AI continues consolidation** with the increasing number of later stage mega-rounds, including those of Insitro ($400M), Valo Health ($300M), Exscientia ($265M), Insilico Medicine ($255M) and others. The AI startups pack is clearly differentiating into the leaders, who developed substantial resources, financial leverage, and technological advantage, and others lagging behind — companies with less resources or less mature technology and scientific assets. The latter are usually focused on narrow therapeutic or technological niches, and are following service-oriented business models. Notably, biotech industry is embracing a new powerful trend of bringing companies to public markets via Special Purpose Acquisition Companies (SPACs). Valo Health has been a most recent example of an AI-driven company having exited via SPAC with more than $500M raised.
2. **Pharmaceutical AI sector is "heating up"**, and becomes a lucrative area for specialized biotech investors as well as investor organizations just entering the pharma space with a goal of including high-risk/high-return companies in their investment portfolios. This is backed by several observations, including an ongoing increasing investment activity in this sector during half year 2021, emergence of SPAC pathway to public markets, the increasing rush among leading pharma and contract research organizations (CROs) to compete for partnerships with AI-driven companies, and the increasing amount of proof-of-concept breakthroughs, confirming that AI technology has achieved substantial maturity to be able to bring tangible value for drug discovery — far beyond a simple optimization gain.
3. **Big pharma and contract research organizations increasingly compete for AI partnerships**, and continue building in-house AI workflows — driven by rapidly emerging evidence of the AI tech feasibility and innovation potential. A number of highly notable proof-of-concept results has been announced during half year 2021, including Insilico Medicine's groundbreaking discovery of novel target and preclinical drug candidate for Idiopathic Pulmonary Fibrosis (IPF).
4. **COVID-19 pandemics appears to be a positive catalyst for the acceleration of the AI adoption** by the pharmaceutical organizations. This is primarily stipulated by the necessity to rapidly process vast amounts of data, and come up with innovations under strict deadlines. Therefore, this urgency pushed companies and investors into more opportunistic projects than ever before.

Major Observations for Q1-Q2 2021: Key Financial and Investment Takeaways

1. The global COVID19 pandemics prolongs the rise of the **overall biotech and drug discovery sectors**. During Q1-Q2 2021 we have observed over 50 medium and large funding rounds for biotech and drug design companies, especially those focused on antiviral therapies and vaccines.
2. A number of successful **AI-driven companies closed large-sum late-stage venture capital rounds (B, C, and D)** in 2021 and several of them are now developing clinical stage drug candidates. We expect some of them go public in 2021-2022: e. g. Valo Health announced it's going public via a $2.8B SPAC merger with Khosla Ventures, expected to close in Q3 2021; Oncocross targets IPO in Q4 2021 to accelerate AI-drug development.
3. Half year 2021 was marked by a notable IPO in the AI-driven drug design space: 3 companies out of 300 under analysis have closed IPOs. Salt Lake City-based **Recursion Pharmaceuticals** closed its IPO in April and ramped up its IPO target from $100M to $306M. **Biomea Fusion**, dedicated to developing innovative medicines targeting genomically defined alterations in both hematologic and solid cancers, and **Evaxion Biotech** devoted to the discovery and development of vaccines against cancer and infectious diseases, have closed their IPOs and demonstrated solid performance.
4. When some of the companies complete IPOs in the nearest future, **it will attract a significant number of non-biotech investors to enter the Life Sciences sector.** The prospects of this trend are already vivid: big tech companies enter partnerships with both innovative startups and pharma companies to consolidate resources mainly in personalized medicine, cell and gene therapy and molecule prediction software.
5. The growing industry traction, reflected in the increasing number of R&D partnerships between big pharma and CROs with AI startups, is a sign that **the market is maturing for rapid increase in M&A activity** in the nearest future.
6. Despite the crisis, publicly traded companies present rapid growth with reached **$27.07B of cumulative capitalization** as of June 30 2021.

Key Technology Takeaways

1. AI is regarded by some top executives at big pharma (**GSK and others**) as **a tool to uncover not only new molecules, but also new targets**. Ability of deep neural networks to build ontologies from multimodal data (e.g. "omics" data) is believed to be among the most disruptive areas for AI in drug discovery, alongside with data mining from unstructured data, like text (using natural language processing, NLP).
2. There is **a considerable trend for "AI democratization"** where various machine learning/deep learning technologies become available in pre-trained, pre-configured "of-the-shelf" formats, or in relatively ready-to-use formats — via cloud-based models, frameworks, and drag-and-drop AI-pipeline building platforms (for example, KNIME). This is among key factors in the acceleration of AI adoption by the pharmaceutical organizations — where a non-AI experts can potentially use fairly advanced data analytics tools for their research.
3. **Proof-of-concept projects keep yielding successful results** in research studies, and in the commercial partnerships alike. For example, companies like Recursion Pharmaceuticals, Insilico Medicine, Deep Genomics, and Exscientia achieved important research milestones using their AI-based drug design platforms.

Obstacles That Still Remain

1. **Global shortage of AI talent** continues to be a serious challenge for the biopharma industry, repeating the trend from our previous reports. While big pharmaceutical companies invest substantial capital in recruitment of AI specialists, still the majority of them are acquired by large tech corporations (Google, Amazon, Alibaba, Tencent, Baidu etc.) However, a growing wave of specialized university programs and courses, geared towards data science and AI application, is projected to address this issue to certain extent in the coming years.
2. **Lack of available quality data is still a challenge for the unleashing full potential of deep learning technologies.** Numerous variations of deep learning (DL) are believed to be the most lucrative area of AI for applications such as drug discovery and clinical research. The key challenge is that DL algorithms are "data-greedy", while big data in biotech is not always well-versed for modeling, or is inaccessible due to privacy reasons.
3. **Ethical, legal, and regulatory issues for AI adoption in the pharmaceutical sciences.** This set of challenges is related to the previous point, but also includes other questions — AI explainability, patentability of AI-generated results, non-optimal regulations in various countries, slowing down the progress and adoption of AI technologies in general, and in the pharmaceutical industry in particular.

AI in the Global Context

US is a main player in AI industry. In the beginning of AI implementation, US was a pioneer and then the main player with the greatest number of companies using AI to force R&D, research centres and institutes, and investments. However, we observe the increased level of the UK and EU activity through big corporations that use AI to reorganise drug discovery and in launching government initiatives. It is also important to note a great increase in activity from the Asia-Pacific region generally, and particular from China — AI superpower.

China engages in extensive investment activity. In particular, it has promised to invest $5B in AI. Tianjin, one of the biggest municipalities, is going to invest $16B in its local AI industry, and the Beijing authorities will build $2.12B AI development project. China also has at least ten privately owned AI startups valued at more than US$1 billion. Moreover, China has been heavily investing in biotech R&D, although lately a serious decrease in Chinese investment in US biotech startups has been observed which can be explained by the trade conflicts between the US and China.

China plans to become the world AI leader by 2030, according to the AI Strategic Plan released in July 2017. The analysis of the the Asia-Pacific region has shown that the main forcers of AI implementation include Saama Technologies, Inc., a leading clinical data analytics company. It has announced a collaboration with researchers at the Tufts Center for the Study of Drug Development to ascertain how biopharmaceutical companies optimize automation and information technologies, including machine learning and neural networks, to support the research and development of new therapeutics. Moreover, XtalPi provides a huge number of talent to work with machine learning, create drug discovery and development applications that predict the properties of small molecules. Another innovators of Asian AI industry are Cytlimic and Fujitsu that offer software for predicting how well compounds will bind with each other and proteins.

Europe has traditionally been a strong breeding ground for biopharma activity, with some recent large valuations and mega deals. The UK and EU activity in the pharmaceutical AI race is mainly boosted by Novartis that announced the partnership with Hewlett Packard Enterprise, US-based company to to advance Novartis global health efforts (June, 2021). Furthermore, UK-based BenevolentAI and AstraZeneca achieved the collaboration milestone with novel AI-generated chronic kidney disease target identified through the Benevolent Platform and AstraZeneca's scientific expertise and rich datasets. One more UK-based company, Lifebit Biotech Ltd, has partnered with Boehringer Ingelheim to utilise AI for the detection and early reporting of global disease outbreaks using real-world data. Iktos, France-based company utilizing AI for drug design has announced two partnerships in 2021. The first one was entered into with Kadmon to enable the rapid and cost-effective design of novel drug candidates, while the second was concluded with Pfizer to apply Iktos AI-driven de novo design software to a number of Pfizer's small-molecule programs. This all demonstrate that Pharma is increasingly turning to AI to transform the drug discovery process.

Appendix:
List of Entities



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300 Companies Applying AI for Drug Discovery and Advanced R&D

1. A2A Pharmaceuticals
2. AccutarBio
3. Acellera
4. AcuraStem
5. ADVIN
6. Aetion
7. AI Therapeutics
8. AiCure
9. Aiforia
10. Aigenpulse
11. Aizon
12. Alector
13. AlgoDx
14. Allelica
15. Alphanosos S.A.S.
16. Altis Labs
17. Amplion
18. Anima Biotech
19. Antidote.me
20. Antiverse
21. ApexQubit
22. Aqemia
23. Arbor Biotechnologies
24. Arctoris
25. Ardigen
26. Ares Genetics GmbH
27. Aria Pharmaceuticals
28. Ariana Pharma
29. Arpeggio Bio
30. Arrakis Therapeutics
31. Arzeda
32. Athelas
33. Atomwise
34. Auransa
35. Banjo Health
36. BenchSci
37. BenevolentAI
38. Berg
39. Berkeley Lights
40. BigHat Biosciences
41. BIOAGE LABS
42. BioBetter
43. Biodesix
44. Biofourmis
45. Biomea Fusion
46. Biorelate
47. BioSymetrics
48. bioSyntagma
49. biotx.ai
50. Biovista
51. BioXcel Therapeutics
52. Bioz
53. BlackThorn Therapeutics
54. Bloomsbury Pharma AI Ltd.
55. BullFrog AI
56. C4X Discovery
57. Calico
58. Cambridge Cancer Genomics
59. CaroCure Discovery Solutions Private Limited
60. Causaly
61. Celeris Therapeutics
62. Cellarity
63. Celsius Therapeutics
64. ChemPass Kft
65. Clinithink
66. Cloud Pharmaceuticals
67. CloudMedx
68. Clover Therapeutics
69. Collaborations Pharma
70. Collective Scientific, LLC
71. Concerto Healthcare
72. Coral Genomics
73. Cotinga Pharmaceuticals
74. Cyclica
75. CytoReason
76. Cytox

300 Companies Applying AI for Drug Discovery and Advanced R&D

77. Data2Discovery
78. Data4Cure
79. Datavant
80. Deep 6 AI
81. Deep Genomics
82. Deep Intelligent Pharma
83. Deep Lens
84. DeepMatter Group
85. DeepMind
86. Denovicon Therapeutics
87. DEXSTR
88. DNAnexus
89. doc.ai
90. Elucidata
91. Emedgene
92. Emerald Cloud Lab
93. Empiric Logic
94. Engine Biosciences
95. EntheogeniX Biosciences
96. Envisagenics
97. Erasca
98. eTherapeutics
99. Euretos
100. Evaxion Biotech
101. Evid Science
102. Evolutionary Genomics
103. Exscientia
104. Fabric Genomics (formerly Omicia)
105. FDNA
106. Fibronostics
107. Flagship Biosciences
108. Flatiron Health
109. Foundation Medicine
110. Frontier Medicines
111. Fulmz AI
112. Gatehouse Bio
113. Genesis Therapeutics
114. GENFIT
115. Genialis
116. Genome Biologics
117. Gero
118. Globavir
119. GlucoGear
120. GNS Healthcare
121. Gordian Biotechnology
122. Gritstone Oncology
123. GT Apeiron Therapeutics
124. Hangzhou Just Biotherapeutics
125. Healx
126. HelixAI
127. Hinge Therapeutics
128. Histoindex
129. HistoWiz
130. Human Longevity
131. iCarbonX
132. icometrix
133. IDEAYA Biosciences
134. Iktos
135. Imagia
136. Imaginostics
137. Immunai
138. ImmunoMind
139. Inato
140. Indegene
141. Ingentium
142. Innophore
143. Innoplexus
144. Insilico Medicine
145. Insitro
146. Intellegens
147. Intelligencia
148. Interprotein
149. Intomics
150. InveniAI
151. InVivo AI

300 Companies Applying AI for Drug Discovery and Advanced R&D

152. Iris.ai
153. ITeos Therapeutics
154. JADBio
155. Keen Eye Technologies
156. Kite Pharma
157. Kuano
158. KYAN Therapeutics
159. Kyndi
160. LabGenius
161. LabTwin
162. Lantern Pharma
163. Linguamatics
164. Longenesis
165. MAbSilico
166. Massive Bio
167. Medable
168. MediBIC Group
169. MediRita
170. MedView Technologies
171. Mendel.ai
172. Menten AI
173. Meta
174. mettleAI
175. Micar Innovation (Micar21)
176. MNM Diagnostics
177. Molecular Fingerprint
178. Molecule.one
179. Molomics Biotech SL
180. Muzi
181. Nanna Therapeutics
182. NetraMark
183. Neuron23
184. NeuScience
185. nference
186. Nimbus Therapeutics
187. Notable
188. Notable Labs
189. Novadiscovery
190. Novoheart Holdings
191. nQ Medical
192. Nucleai
193. NuMedii
194. Numerate
195. Nurenyx Inc.
196. Nuritas
197. OccamzRazor
198. OKRA Technologies
199. Olaris
200. Oncocross
201. OneThree Biotech
202. Optibrium
203. Owkin
204. Paradigm4, inc.
205. PatchAi
206. PathAI
207. PatSnap
208. PEACCEL
209. Pending.AI
210. Pepticom Ltd.
211. Peptone
212. Pera Labs
213. Percayai
214. Perceiv AI
215. Pharmacelera
216. PharmCADD
217. Pharos iBT
218. Phenomic AI
219. Phenomics Health
220. Plex Research
221. Polaris Quantum Biotech
222. PostEra
223. Precisionlife
224. Presagen
225. Prognica Labs
226. Proscia

300 Companies Applying AI for Drug Discovery and Advanced R&D

227. ProteinQure
228. Quertle
229. Quibim
230. Qview Medical
231. Qynapse
232. Recursion Pharmaceuticals
233. Relay Therapeutics
234. Remedium
235. Renalytix AI
236. Repurpose.AI
237. Researchably
238. Resonant Therapeutics
239. Reveal Biosciences
240. Reverie Labs
241. ReviveMed
242. Roivant Sciences
243. Saama
244. Sage-N Research
245. Sangamo Therapeutics
246. Satalia
247. Scailyte
248. Schrödinger
249. sciNote
250. Segmed
251. SEngine Precision Medicine
252. Sensyne Health
253. Sigma Technologies, Ltd.
254. Silexon
255. Silicon Therapeutics
256. Simply Speak
257. Sirenas Marine Discovery
258. SOM Biotech
259. SOPHiA GENETICS
260. Sparrho
261. Spectral MD
262. Spring Discovery
263. Standigm
264. Steel Therapeutics
265. StoneWise
266. Strados Labs
267. Strateos
268. Structura Biotechnology
269. Synergy Pharmaceuticals
270. Synsight
271. Syntekabio, Inc.
272. Synthace
273. Systems Oncology
274. TARA Biosystems
275. Tempus
276. TeselaGen
277. ThoughtSphere Inc.
278. ThoughtSpot
279. TrialJectory
280. Trials.ai
281. Turbine
282. uBiome
283. Ultromics
284. Unlearn.AI
285. Unnatural Products
286. Valo Health
287. Variational AI
288. Verge Genomics
289. VeriSIM Life
290. Virogin Biotech
291. Volta Medical
292. Vyasa Analytics
293. Winterlight Labs
294. Wisecube
295. WuXi AppTec
296. X-37
297. Xbiome
298. xCures
299. XtalPi
300. ZappRx
301. ZebiAI

880+ Investors AI for Drug Discovery and Advanced R&D

1. 10x Group
2. 11.2 Capital
3. 180 Degree Capital
4. 360 Capital
5. 4FO Ventures
6. 500 Startups
7. 500 Startups Canada
8. 5AM Ventures
9. 5Y Capital
10. 6 Dimensions Capital
11. 7BC Venture Capital
12. 8VC
13. A-Level Capital
14. A&E Investments
15. AbbVie
16. AbbVie Biotech Ventures
17. Abstract Ventures
18. Acadia Woods Partners
19. Accel X
20. Accelerate Long Island
21. Accelmed
22. Access Industries
23. ACE & Company
24. Acequia Capital (AceCap)
25. ACF Investors
26. ACME Investments
27. Acorn Bioventures
28. Adage Capital Management
29. Adara Ventures
30. Advantage Capital
31. Advent Life Sciences
32. Afore Capital
33. Agent Capital
34. AI Seed
35. Air Street Capital
36. Aisling Capital
37. AJS Investments
38. Alcazar Capital
39. Alchemist Accelerator
40. Alexandria Real Estate Equities
41. Alexandria Venture
42. Alexandria Venture Investments
43. AllBright
44. Allen & Company
45. Ally Bridge Group
46. Almanack Family Office
47. Alpha Intelligence Capital
48. AlpInvest Partners
49. ALS Investment Fund
50. Altitude Life Science Ventures
51. Alumni Ventures Group
52. Alychlo
53. Amadeus Capital Partners
54. Amazon Alexa Fund
55. AME Cloud Ventures
56. Amgen Ventures
57. Amidi Group
58. Amino Capital
59. aMoon Fund
60. Amplify Capital
61. Amplify Partners
62. Amplify.LA
63. Amplitude Venture Capital
64. Andreessen Horowitz
65. Angels 5K
66. Angels Capital
67. Angels in MedCity
68. Anges Quebec
69. APEX Ventures
70. Aravis Ventures
71. Arboretum Ventures
72. ARCH Venture Partners
73. ARPA-E
74. ArrowMark Partners
75. Artis Ventures (AV)

880+ Investors AI for Drug Discovery and Advanced R&D

76. Asahi Kasei
77. Asas Capital
78. Ascend Capital Partners
79. Asset Management Ventures (AMV)
80. Asset One
81. Astia Angels
82. Atinum Investment
83. Atlantic Bridge
84. Atlas Venture
85. Atmos Ventures
86. Atomico
87. AV8 Ventures
88. Avidity Partners
89. Aviva Ventures
90. Axel Investments
91. B Capital Group
92. Babel Ventures
93. BACKED VC
94. Baidu Ventures
95. Baillie Gifford
96. Baird Capital
97. Bakken & Baeck
98. Balderton Capital
99. Bangarang Group
100. Bank of China
101. Bank of Hangzhou
102. Bantam Group
103. Baron Capital Management
104. Basis Set Ventures
105. Bay City Capital
106. BB Biotech Ventures
107. BDC Healthcare Venture
108. BDC Venture Capital
109. Beast Ventures
110. Ben Franklin Technology Partners of Southeastern Pennsylvania
111. Bend Venture Conference
112. Berggruen Holdings
113. Better Ventures
114. Bezos Expeditions
115. BGS Venture
116. BIG BOOSTER
117. Big Pi Ventures
118. Bill & Melinda Gates Foundation
119. Bioeconomy Capital
120. Biomatics Capital Partners
121. Bios Partners
122. Biospring Partners
123. Biotechnology Value Fund
124. BioVenture
125. Bioverge
126. Black Diamond Ventures
127. BlackRock
128. BlackRock Innovation Capital
129. Bloomberg Beta
130. Blue Bear Ventures
131. Blue Ivy Ventures
132. Blumberg Capital
133. BOCGI Zheshang Capital
134. Boehringer Ingelheim Venture Fund
135. Bold Capital Partners
136. BootstrapLabs
137. Boston Angel Club
138. Boundary Capital Partners LLP
139. Boxer Capital
140. BoxGroup
141. Bpifrance
142. Brightspark Ventures
143. Brinc
144. Bristol-Myers Squibb
145. btov Partners
146. Buchanan Investments
147. Builders VC
148. Bulba Ventures
149. Business Finland
150. BVF Partners

880+ Investors AI for Drug Discovery and Advanced R&D

151. Caffeinated Capital
152. Calculus Capital
153. California Institute for Regenerative Medicine
154. Cambia Health Solutions
155. Cambridge Angels group
156. Canaan Partners
157. Canada Pension Plan Investment Board
158. Cantos
159. Capikris Foundation
160. Capital One Growth Ventures
161. Capricorn Partners
162. Carlyle Global Partners
163. Cascade Investment
164. Cascade Seed Fund
165. Casdin Capital
166. Castor Ventures
167. Catalio Capital Management
168. Catapult Ventures
169. Cathay Innovation
170. Cathexis Ventures
171. Cavendish Impact Capital
172. Celesta Capital
173. Celgene
174. Centene
175. Champion Hill Labs
176. Cherubic Ventures
177. Chiesi Pharmaceuticals
178. China Bridge Capital
179. China Canada Angel Alliance
180. China Equity
181. Cigna Ventures
182. CITIC Industrial Investment Group
183. Citrix Startup Accelerator
184. Citrix Systems
185. City Hill Ventures
186. Civilization Ventures
187. CKA Capital Ltd
188. Claremont Creek Ventures
189. Clarus Ventures
190. CLI Ventures
191. CM-CIC Capital Finance
192. Colorcon
193. Colt Ventures
194. Columbia Capital
195. Congressionally Directed Medical Research Programs
196. Connecticut Innovations
197. Contour Venture Partners
198. Conversion Ventures LLC
199. Cormorant Asset Management
200. Cosine
201. Cota Capital
202. Cowen Healthcare Investments
203. CPE
204. Creative Destruction Lab (CDL)
205. Credit Suisse
206. Crista Galli Ventures
207. Crosslink Capital
208. Crowdcube
209. CRV
210. CTI Life Sciences Fund
211. Cultivian Sandbox Ventures
212. curative ventures
213. D. E. Shaw Research
214. D1 Capital Partners
215. Daishin Securities
216. Darling Ventures
217. DCM Ventures
218. DCVC
219. DCVC Bio
220. Debiopharm Group
221. Debiopharm Innovation Fund
222. Decacorn Capital
223. Deep Knowledge Ventures
224. Deerfield
225. Deerfield Capital Management

880+ Investors AI for Drug Discovery and Advanced R&D

226. Deerfield Management
227. DEFTA Partners
228. Dementia Discovery Fund
229. Density Ventures
230. Dentsu
231. Desjardins-Innovatech
232. Development Bank of Wales
233. Dexcel Pharma
234. DHVC
235. Digital Science
236. DigiTx Partners
237. DNA Capital
238. Dolby Family Ventures
239. Dorm Room Fund
240. Draper Associates
241. Draper Dragon
242. Dreamit Ventures
243. Driehaus Capital Management
244. Drive Capital
245. DROIA
246. dRx Capital
247. DSC Investment
248. DTRIBE Capital
249. Duquesne Family Office
250. Dynamk Capital
251. EASME - EU Executive Agency for SMEs
252. Eastern Bell Capital
253. EBRD (Investment Firm)
254. Echo Health Ventures
255. EcoR1 Capital
256. EDBI
257. Eden Strategy Institute
258. Eight Roads Ventures
259. Eisai
260. Elaia
261. Elev8.VC
262. Eli Lilly
263. Emerald Development Managers
264. Emerge Education
265. Emerging Technology Partners
266. Endeavour Vision
267. Endure Capital
268. ENISA
269. Entrepreneur First
270. EPIC Capital
271. EPIC Ventures
272. Era Funding Administration
273. Esperante Ventures
274. Euclidean Capital
275. Eurazeo
276. European Bank for Reconstruction and Development
277. European Innovation Council
278. European Union
279. Eurostars
280. Evotec
281. F-Prime Capital
282. Fairhaven Capital Partners
283. Famillie C (Clarins Family)
284. Farallon Capital Management
285. Federated Kaufmann Fund
286. Felicis Ventures
287. Fidelity
288. Fidelity Canada
289. Fidelity Management and Research Company
290. Fifty Years
291. Firlej Kastory
292. First Round Capital
293. First Star Ventures
294. Fitz Gate Ventures
295. Flagship Pioneering
296. Flare Capital Partners
297. Flex Capital
298. Fly Ventures
299. Flybridge
300. Fonds Vives II (University of Louvain, UCL)

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301. Foresite Capital
302. Forestay Capital
303. Formic Ventures
304. Foundation Capital
305. FounderFuel
306. Founders Factory
307. Founders Fund
308. FoundersX Ventures
309. Franklin Templeton
310. Franklin Templeton Investments
311. Frazier Healthcare Partners
312. Front Row Fund
313. Fund+
314. FundersClub
315. Fushia Investments
316. Fusion Fund
317. Future Fund
318. Future Shape
319. Future Ventures
320. Gaorong Capital
321. Garage Capital
322. GE Ventures
323. Geekdom Fund
324. GEIF Ventures
325. General Atlantic
326. General Catalyst
327. Generation Investment Management
328. Genuity Science
329. Geodesic Capital
330. GGV Capital
331. Gi Global Health Fund LP
332. Gilde Healthcare
333. GL Ventures
334. Glade Brook Capital Partners
335. Global Brain Corporation
336. Global Founders Capital
337. GM&C Life Sciences Fund
338. GNI Group
339. Golden Seeds
340. Golden Ventures
341. Good Growth Capital
342. Goodman Capital
343. Google
344. Government Of Quebec
345. Gradient Ventures
346. Grand Central Tech
347. Grand Challenges Canada
348. Grape Arbor VC
349. Great Oaks Venture Capital
350. Greater Bay Area Homeland Development Fund
351. Green Park & Golf Ventures
352. GreenSky Capital
353. Greenspring Associates
354. Grey Sky Venture Partners
355. Greycroft
356. Greylock
357. GRIDS Capital
358. Groupe Pasteur Mutualité
359. Grove Ventures
360. GSR Ventures
361. GT Healthcare Capital Partners
362. GV
363. Hacking Health Accelerator
364. Hanhai Studio
365. HarbourVest Partners
366. Harmonix
367. Harpoon
368. HAX
369. HBM Healthcare Investments AG
370. HBM Partners
371. HealthInc
372. Healthware Ventures
373. Hemex
374. Hemi Ventures
375. Heritage Provider Network

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376. Hewlett Packard Pathfinder
377. Highland Capital Partners
378. HIGHLINEvc
379. Hike Ventures
380. Hikma Ventures
381. Hillhouse Capital Group
382. Hitachi Ventures
383. Hiventures
384. HOF Capital
385. Holtzbrinck Digital
386. Honeywell Venture Capital
387. Hongyou Investment
388. Horizon 2020
389. Horizon Healthcare Services
390. Horizons Ventures
391. Hoxton Ventures
392. Human Capital
393. Hunza Ventures
394. Hyperplane Venture Capital
395. IA Ventures
396. Idinvest Partners
397. iGan Partners
398. Illumina
399. Illumina Ventures
400. Imagen Capital Partners
401. Imperial Create Lab
402. Inbio Ventures
403. Index Ventures
404. IndieBio
405. Industry Ventures
406. Initialized Capital
407. Innospark Ventures
408. Innovate UK
409. Innovation Endeavors
410. Innovatus Capital Partners
411. Inovia Capital
412. Institut Català de Finances (ICF Capital)
413. Intel Capital
414. Intermountain Healthcare
415. Intermountain Ventures
416. International Private Bank (IPB)
417. InterVest Co.
418. Inventures
419. Invoke Capital Partners
420. Invus
421. IQ Capital
422. Isomer Capital
423. IvyCap Ventures
424. J. Hunt Holdings
425. Janssen Belgium
426. Janus Henderson Investors
427. Jazz Venture Partners
428. Jianke
429. Jiantou Huawen Investment
430. Johnson & Johnson Innovation
431. Johnson & Johnson Innovation – JJDC
432. Juvenescence
433. K9 Ventures
434. Kaiser Foundation Hospitals
435. Kaiser Permanente
436. Kakao Ventures
437. Kapor Capital
438. Karlin Ventures
439. KB Securities
440. KDB Bank
441. KDB Capital
442. KdT Ventures
443. Keiretsu Forum
444. Kepha Partners
445. Khosla Ventures
446. Kima Ventures
447. Kindred Capital
448. Kleiner Perkins
449. Koch Disruptive Technologies
450. Krohne

880+ Investors AI for Drug Discovery and Advanced R&D

451. KTB Network
452. La Famiglia
453. LabCorp
454. Lake Bleu Capital
455. Lakestar
456. Launch Lane
457. LaunchCapital
458. Laurion Capital Management
459. LB Investment
460. LBO France
461. LDV Partners
462. Leaps by Bayer
463. Legend Capital
464. Life Sciences Angel Network
465. Life Sciences Partners
466. Life Sciences Research Partners V.Z.W.
467. Lifeforce Capital
468. LifeSci Venture Partners
469. Lightspeed China Partners
470. Lightspeed Venture Partners
471. Lightstone Ventures
472. Lilly Asia Ventures
473. Lilly Ventures
474. Linden Mobile Ventures
475. Linear Capital Partners
476. Linear Venture
477. Liquid 2 Ventures
478. Logos Capital
479. London Co-Investment Fund
480. Long Hill Capital
481. Longevity Vision Fund
482. Loup Ventures
483. Lucas Venture Group
484. Luminous Ventures
485. Lux Capital
486. LVL1 Group
487. M12
488. Mack-Cali Realty Corporation
489. MACSF
490. Madrona Venture Group
491. Magnetic Ventures
492. Maison Capital
493. Manchester Tech Trust Angels
494. Marathon Venture Capital
495. Marketplace Funds
496. MaRS Discovery District
497. Marshall Wace
498. Masa Life Science Fund
499. MassChallenge
500. MassMutual Ventures Southeast Asia (MMV SEA)
501. Matrix Capital Management
502. Matrix Partners
503. Maverick Ventures
504. Mayo Clinic
505. Mayo Clinic Ventures
506. McKesson Ventures
507. MedTech Innovator
508. Menlo Ventures
509. Merck
510. Merck Global Health Innovation Fund
511. Mercury Fund
512. Meridian Street Capital
513. Mérieux Equity Partners
514. Metaplanet Holdings
515. Michael J. Fox Foundation
516. Microsoft
517. MidCap Financial
518. Midven
519. Mighty Capital
520. Millennium Technology Value Partners
521. Mirae Asset Capital
522. Mirae Asset Venture Investment
523. Mission and Market
524. Mission Bay Capital
525. Mission BioCapital

880+ Investors AI for Drug Discovery and Advanced R&D

526. MIT delta v
527. MITS Fund
528. Mitsui & Co
529. Monsanto Growth Ventures (MGV)
530. Morgan Noble
531. MPM Capital
532. MRL Ventures Fund
533. MSA Capital
534. Mubadala
535. Mubadala Capital | Ventures Europe
536. Mubadala Capital | Ventures US
537. MVM Life Science Partners
538. National Heart, Lung and Blood Institute
539. National Human Genome Research Institute
540. National Institute of Neurological Disorders and Stroke
541. National Institutes of Health
542. National Science Foundation
543. Neo
544. Neoteny
545. Neptune Investment Management
546. Nest.Bio Ventures
547. Nesta Ventures
548. Neue Fund
549. New Enterprise Associates
550. New Leaf Venture Partners
551. New York State
552. New York Ventures
553. Newable Ventures
554. Newchip
555. NewDo Venture
556. Nex Cubed
557. Nex Cubed Digital Health
558. NEXT Canada
559. Next Play Capital
560. NextAI
561. Nextech Invest
562. NextFab
563. NIF Ventures
564. Nikon
565. Nimble Ventures
566. Nina Capital
567. NJF Capital
568. Nordic Impact
569. Northleaf Capital Partners
570. Northpond Ventures
571. Northstar Ventures
572. Novaquest Capital Management
573. Novartis Institutes
574. Novartis Venture Fund
575. Novatio Ventures
576. Novo Holdings
577. NPIF Maven Equity Finance
578. NTT Venture Capital
579. Nvidia Inception
580. Oak HC/FT
581. Obvious Ventures
582. OCA Ventures
583. Octopus Ventures
584. Olive Tree Capital
585. Omega Funds
586. OMX Ventures
587. Ontario Centres of Excellence
588. Open Field Capital
589. Openspace Ventures
590. OrbiMed
591. Origin Capital
592. OS Fund
593. Oséo
594. Otium Capital
595. OTV
596. OUP (Osage University Partners)
597. Outsized Ventures
598. Oxeon Partners
599. Oxford Sciences Innovation
600. Pacific Health Ventures

880+ Investors AI for Drug Discovery and Advanced R&D

601. Palisades Growth Capital
602. Panache Ventures
603. Partech
604. Partner Fund Management
605. Partnership Fund for New York City
606. Pavilion Capital
607. Paxion Capital Partners
608. Pear VC
609. Pentech Ventures
610. Perceptive Advisors
611. Perivoli Innovations
612. Perot Jain
613. Pfizer
614. Pfizer Venture Investments
615. PHC Holdings
616. Pi Campus
617. Pictet Private Equity Investors S.A.
618. Pillar VC
619. Ping An Ventures
620. Pioneer Fund
621. Pitch@Palace
622. Pivotal bioVenture Partners
623. PivotNorth Capital
624. Plug and Play Tech Center
625. Point Sur Investors
626. Point72 Ventures
627. Polaris Partners
628. Portland Seed Fund
629. PPD
630. Prairie Ventures
631. Prefix Capital
632. Premier Partners
633. President International Development Corporation
634. Princeton Alumni Angels
635. Pritzker Group Venture Capital
636. Propagator Ventures
637. Propel(X)
638. PSP Investments
639. Qiming Venture Partners
640. Qualgro VC
641. QVentures
642. QVT Financial
643. RA Capital Management
644. Radical Ventures
645. Ramen Ventures
646. Razor's Edge Ventures
647. Real Ventures
648. Redalpine
649. Redmile Group
650. Redpoint
651. Refactor Capital
652. Reference Capital (formerly Genevest)
653. Regeneron
654. Reneo Capital Management
655. Rev1 Ventures
656. Revo Capital
657. Revolution
658. Revolution Growth
659. Revolution's Rise of the Rest Seed Fund
660. Rho Canada Ventures
661. Rho Ventures
662. Ridgeback Capital
663. Right Side Capital Management
664. Rivas Capital
665. Robin Hood Ventures
666. Roca X
667. Roche
668. Roche Venture Fund
669. Rock Springs Capital
670. Rockies Venture Club
671. Roivant Sciences
672. Romulus Capital
673. Rough Draft Ventures
674. RT Ventures
675. RTAventures VC

880+ Investors AI for Drug Discovery and Advanced R&D

676. RTW Investments LLC
677. Ruvento
678. S.R.I.W.
679. Sage Partners
680. Samsara BioCapital
681. Sanabil
682. Sandbox Industries
683. Sanofi
684. Sanofi Ventures
685. Sapphire Ventures
686. Scale Venture Partners
687. Schooner Capital
688. Schrödinger
689. Schusterman Foundation
690. SciFi VC
691. Scottish Mortgage Investment Trust
692. Sea Lane Ventures
693. Section 32
694. Seneca Partners
695. Sequoia Capital
696. Sequoia Capital China
697. Sequoia Capital India
698. Seraph Group
699. Serena
700. Serra Ventures
701. Service Provider Capital
702. ServiceNow
703. Seven Peaks Ventures
704. SFEM Italia
705. SFPI-FPIM
706. SGInnovate
707. Shangbay Capital
708. Shasta Ventures
709. Shengding Equity Investment Fund
710. Shunwei Capital
711. Sierra Ventures
712. SIG China (SIG Asia Investments)
713. Sigma Prime Ventures
714. Silicon Badia
715. Silicon Valley Bank
716. Silicon Valley Ventures
717. Silver Lake Waterman
718. Singtel Innov8
719. Sinovation Ventures
720. Sixty Degree Capital
721. SK Holdings
722. SKS PE
723. Sky Ventures Group
724. Slow Ventures
725. Small Business Innovation Research
726. Smedvig Capital
727. Snowflake Ventures
728. Social Capital
729. Social Impact Capital
730. Sofinnova Partners
731. Softbank Ventures Asia
732. SoftBank Vision Fund
733. Soma Capital
734. SOSV
735. Sound Ventures
736. South Park Commons
737. SPARK Impact
738. SpesNet Pte. Ltd.
739. SpringRock Ventures
740. Square 1 Bank
741. SR One
742. Stage Venture Partners
743. Starlight Ventures
744. Start Capital
745. Startup Capital Ventures
746. StartUp Health
747. StartX (Stanford-StartX Fund)
748. Sto-Rahoitus
749. Streamlined Ventures
750. Stripes

880+ Investors AI for Drug Discovery and Advanced R&D

751. Summit Partners
752. Sunfish Partners
753. Surveyor Capital
754. Susa Ventures
755. Sustainable Conversion Ventures
756. SV Angel
757. SV Tech Ventures
758. Sway Ventures
759. Swisscom Ventures
760. SyndicateRoom
761. Synthetic Genomics
762. System.One
763. T. Rowe Price
764. Tachyon Ventures
765. Taikang Asset
766. Taikang Life Insurance
767. Tamarind Hill
768. Tanarra Credit Partners
769. Tavistock Group
770. TCP Venture Capital
771. TD Veen
772. Teal Ventures
773. Team Builder Ventures
774. Tech Coast Angels
775. Tech Transfer UPV
776. Techammer
777. Techstars
778. Techstars Montreal AI Accelerator
779. TechU Ventures
780. Temasek Holdings
781. Temple University
782. Tencent
783. TenOneTen Ventures
784. Tensor Ventures
785. Terra Magnum Capital Partners ("TMCP")
786. The Baupost Group
787. The Chartered Group
788. The Column Group
789. The Family
790. The Index Project
791. The Longevity Fund
792. The North West Fund
793. The Scripps Research Institute
794. The Syndicate Group
795. The Thiel Foundation
796. The University of Texas System
797. Third Kind Venture Capital
798. Third Rock Ventures
799. Threshold
800. TIA Ventures
801. TiE Angels
802. Tiger Global Management
803. Time Warner Investments
804. Tiny Super Computer Investment Company
805. TLV Partners
806. Topspin Partners
807. Touchdown Ventures
808. TPG Biotech
809. Trancos Ventures
810. Transformation Capital
811. Transformational Healthcare Opportunity
812. Trend Investment Group
813. Tribeca Venture Partners
814. Trinitas Capital
815. True Ventures
816. TSVC
817. TT Capital Partners
818. Tudor Growth Equity
819. Tuesday Capital
820. TVM Capital
821. Twin Capital Management LLC
822. Two Sigma Ventures
823. Two Small Fish Ventures
824. uBiome
825. UCB

880+ Investors AI for Drug Discovery and Advanced R&D

826. UK Innovation & Science Seed Fund
827. UL Ventures
828. Ulu Ventures
829. Uncommon Denominator
830. Uncork Capital
831. Uni-Innovate Group
832. Universal Materials Incubator
833. University of Birmingham
834. University of Delaware
835. University of Minnesota
836. Unshackled Ventures
837. UpHonest Capital
838. UPMC
839. Upscale
840. Upside Partnership
841. UV-Cap
842. Valor Ventures
843. Vanedge Capital
844. Varian
845. Vectr
846. Velocity.Partners
847. venBio Partners
848. Verily
849. Vertex Ventures
850. Vertex Ventures HC
851. Vertex Ventures Israel
852. Vertex Ventures Southeast Asia & India
853. Verve Ventures
854. Viking Global Investors
855. Village Global
856. Viola Group
857. VisVires New Protein
858. Viva BioInnovator
859. Viva Biotech
860. Vives Louvain Technology Fund
861. Voxel Ventures
862. Walden Riverwood Ventures
863. Walking Ventures
864. Warburg Pincus
865. Washington Research Foundation
866. Wellington Management
867. Western Technology Investment
868. Westlake Village BioPartners
869. Westwood Ventures
870. WI Harper Group
871. Wild Basin Investments
872. WONIK Investment Partners
873. WorldQuant Ventures LLC
874. Wren Capital
875. WuXi AppTec
876. WuXi Healthcare Ventures
877. Y Combinator
878. Yahui Investment
879. ZhenFund
880. Zhongyuan Union Cell & Gene Eng
881. Zola Global Investors

31 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
1. AbbVie	United States	abbvie.com
2. Agios Pharmaceuticals	United States	agios.com
3. Amgen	United States	amgen.com
4. Astellas Pharma	Asia	astellas.com
5. AstraZeneca	United Kingdom	astrazeneca.com
6. Bayer	European Union	bayer.com
7. Biogen	United States	biogen.com
8. Boehringer Ingelheim	European Union	boehringer-ingelheim.com
9. Bristol-Myers Squibb	United States	bms.com
10. Celgene	United States	celgene.ca
11. Daewoong Pharmaceutical	United States	daewoong.com
12. Evotec	European Union	evotec.com
13. Genentech	United States	gene.com
14. Gilead Sciences Inc.	United States	gilead.com
15. GSK	United States	gsk.com
16. Ilumina	United States	illumina.com

31 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
17. Ipsen	European Union	ipsen.com
18. Janssen Pharmaceuticals	European Union	janssen.com
19. Johnson & Johnson	United States	jnj.com
20. Merck	United States	merck.com
21. Mitsubishi Tanabe Pharma	Asia	mt-pharma.co.jp
22. Novartis	European Union	novartis.com
23. Novo Nordisk	European Union	novonordisk.com
24. Pfizer	United States	pfizer.com
25. Roche	European Union	roche.com
26. Sanofi	European Union	sanofi.com
27. Santen	United States	santen.com
28. Shionogi	Asia	shionogi.co.jpen
29. Sumitomo Dainippon Pharma	Asia	ds-pharma.com
30. Takeda	Asia	shire.co.jp
31. Teva Pharmaceutical	Asia	tevapharm.com

29 Tech Corporations Applying Advanced AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
1. Adobe	United States	adobe.com
2. Alibaba	United States	alibaba.com
3. Alphabet	China	abc.xyz
4. Amazon	United States	amazon.com
5. Apple	United States	apple.com
6. Baidu	United States	baidu.com
7. Canon	China	usa.canon.com
8. Cisco	United States	ciscoinvestments.com
9. Dell Technologies	United States	delltechnologies.com
10. Foxconn Technology	United States	foxconn.com
11. Fujitsu	Asia	fujitsu.com
12. General Electric (GE)	Asia	ge.com
13. Google	United States	google.com
14. Hitachi	United States	hitachi.com
15. HP	Asia	hp.com

29 Tech Corporations Applying Advanced AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
16. Huawei	United States	huawei.com
17. IBM	China	ibm.com
18. Intel	United States	intel.com
19. LG Electronics	United States	lg.com
20. Microsoft	Asia	microsoft.com
21. NVIDIA	United States	nvidia.comen-in
22. Oracle	United States	oracle.com
23. Salesforce	United States	salesforce.com
24. Samsung Electronics	United States	samsung.comus
25. SAP	Asia	sap.com
26. Siemens	European Union	siemens.com
27. Tencent	European Union	tencent.comen-us
28. Unisys	China	unisys.com
29. Workday	United States	workday.com

21 CROs AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
1. Aptuit	European Union	aptuit.com
2. BioClinica	United States	bioclinica.com
3. Charles River Laboratories	United States	criver.com
4. CMIC	Asia	en.cmicgroup.com
5. Covance	United States	covance.com
6. Galapagos NV	European Union	glpg.com
7. ICON	United States	iconbuild.com
8. IonsGate	Canada	ionsgate.com
9. IQVIA	United States	iqvia.com
10. Iris Pharma	European Union	iris-pharma.com
11. J-STAR Research, Inc. / Porton	United States	jstar-research.com
12. Open Orphan plc	European Union	openorphan.com
13. PAREXEL	United States	parexel.com
14. Phastar	United Kingdom	phastar.com
15. Phlexglobal	United Kingdom	phlexglobal.com
16. PPD	United States	ppd.com
17. PRA International	United States	prainternational.com
18. Samsung Biologics	Asia	samsungbiologics.com
19. SGS	European Union	sgs.com
20. Synsight	European Union	synsight.net
21. WuXi AppTec	China	wuxiapptec.com.cn

15 Chemical Corporations Applying AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
1. Asahi Kasei	Japan	asahi-kasei.co.jp
2. BASF	Germany	basf.com
3. COVESTRO	Germany	covestro.com
4. DIC	Japan	dic-global.com
5. The Dow Chemical Company	United States	dow.com
6. DSM	The Netherlands	dsm.com
7. DUPONT	United States	dupont.com
8. ECOLAB	United States	de-at.ecolab.com
9. EVONIK INDUSTRIES	Germany	corporate.evonik.de
10. Henkel	Germany	henkel.com
11. Lonza	Switzerland	lonza.com
12. MITSUI CHEMICALS	Japan	mitsuichem.com
13. Solvay	Belgium	solvay.de
14. SUMITOMO CHEMICAL	Japan	sumitomo-chem.co.jp
15. SYNGENTA	Switzerland	syngenta.com

Overview of Proprietary Analytics by Deep Pharma Intelligence



DEEP
PHARMA
INTELLIGENCE

About Deep Pharma Intelligence

DEEP PHARMA INTELLIGENCE

Deep Pharma Intelligence is producing regular analytical reports on major areas of high-potential in the pharmaceutical and healthcare industries, maintaining ratings of companies and governments based on their innovation potential and business activity in the BioTech space, and providing strategic consulting and investment intelligence services to top-tier clients, including major investment funds and banks, family offices, insurance companies, government organizations, and big pharma companies among others. The company is a joint venture between the two highly specialized UK-based market intelligence hubs in Pharma / BioTech space:

DEEP KNOWLEDGE ANALYTICS

Pharma Division of Deep Knowledge Analytics (PD-DKA), a specialized subsidiary of Deep Knowledge Analytics (DKA), the leading analytical entity specifically focused on deep intelligence of the high-potential areas in the pharma industry, including artificial intelligence (AI) for drug discovery sector.

Deep Knowledge Analytics Pharma Division serves as the main source of investment intelligence and analytics for AI-Pharma, a specialized index hedge fund for the AI in the drug discovery sector. PD-DKA's insights are frequently covered by top media such as Forbes and the Financial Times, and are acknowledged by top pharma executives.

Recently, MIT named this division a top technology think-tank, acknowledging the AI ranking framework it developed.

Bio Pharma Trend

BPT Analytics (BiopharmaTrend) - a rapidly growing analytical portal and media resource, dedicated to tracking emerging companies (startups/scaleups), innovations, investments, and trends in the pharma and biotech space.

BiopharmaTrend's reports and articles were referenced by Deloitte, Forbes, and other high profile media and consulting companies.

BiopharmaTrend is a media partner to a number of top-tier conferences and symposia in preclinical and clinical research, and healthcare research.

Overview of Proprietary Analytics by Pharma Division of Deep Pharma Analytics

Deep Pharma Intelligence (DPI) is a strategic partner to the leading Life Science organizations, investment institutions (VC funds, investment banks), and governments across the globe — in matters related to investments, strategic positioning, and policy development in the areas of pharmaceutical and biotech research, and healthcare tech.

While Deep Pharma Intelligence is regularly producing open industry reports covering high-growth sectors in the Life Sciences, including artificial intelligence (AI), digital health, and new therapies, some of the more in-depth research is only available to our clients and strategic partners under the "Proprietary Analytics" category.

Our range of proprietary services includes custom consulting projects, based on the specific customer needs, as well as a collection of pre-produced "ready-to-use" proprietary reports, produced by our research team, covering general trends and specific action ideas and strategy insights related to the most promising investment prospects (e.g. new technologies, biotech startups), M&A prospects (e.g. pipeline development targets), and strategic growth ideas (trends profiling, industry overviews etc).

Services:

- Investment landscape profiling, identifying investment ideas in the biotech/healthcare tech space
- Preliminary due-diligence (business, science and technology, intellectual property (IP) profiling, freedom of operation assessment, legal assessment etc)
- Comprehensive due-diligence (deep business, science and technology assessment, IP and legal assessment, growth potential assessment etc)
- Infringement analysis of technology (i.g. If you plan to partner or invest in a data-analytics biotechs, or AI-development vendors, it is essential to understand their technological assets, both in terms of innovation potential and in terms of legal protection and non-infringement risk management)
- SWOT analysis of companies and technological sectors, competitive profiling
- Industry profiling and growth strategy development for top-tier companies and governments.

Overview of Proprietary Analytics by Pharma Division of Deep Pharma Analytics

Proprietary Reports

There are a few 40+ page reports delivering practical answers to these specific questions in order to optimize the short and long-term strategies of biopharma corporations and other institutions related to the industry, with a newly updated edition being released each quarter, incrementally increasing the precision, practicality and actionability of its technological and financial analysis.

Our reports are supported by our rapidly developing data mining engine, data visualization platform and analytics dashboards.

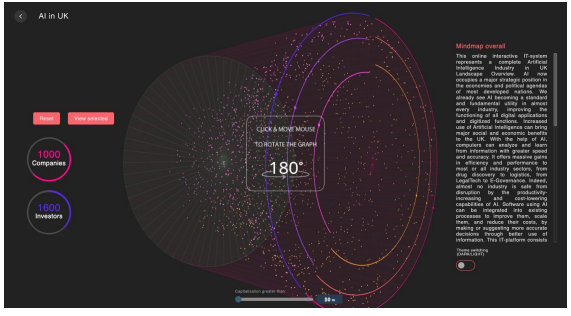
The value our reports can deliver:

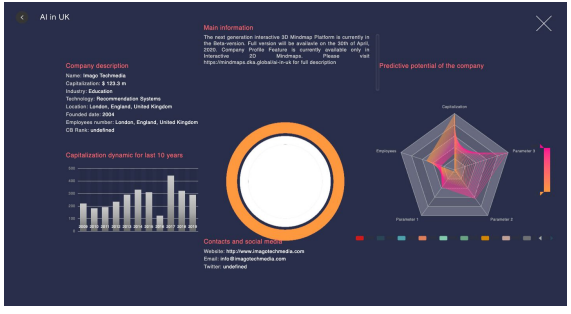
- Deep analysis of the deal-making prospects in the biotech and healthcare tech space, identification of top mini-trends and larger tendencies in innovations and technology adoption (e.g. AI, blockchain, eHealth tech, longevity biomarkers, new therapeutics and therapies etc.)
- Tangible forecasts on the 3-5 years horizon, providing an overview of future scenarios of the development of various technologies in the pharma industry
- Practical guides for adopting various technological solutions and best practises, vendor profiling and contract research strategy building
- Analysis of key market players in the emerging and high-growth areas of the pharmaceutical and biotech industries.

The parties who gain early access to these reports will have deep expertise on how their strategic agendas can be optimized in order to leverage novel research, new technologies, and emerging market opportunities, and stay competitive in a rapidly-changing technological environment, and taking into account shifting global priorities and trends.

Deep Pharma Intelligence: Upcoming Projects and Analytical Tools

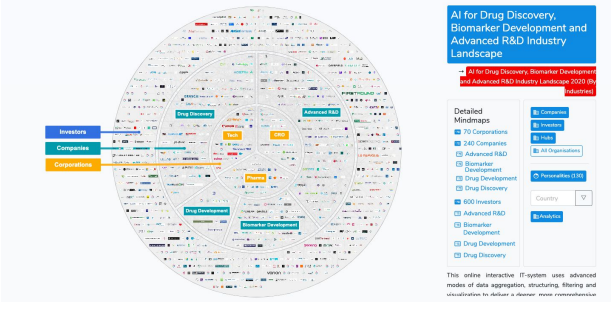






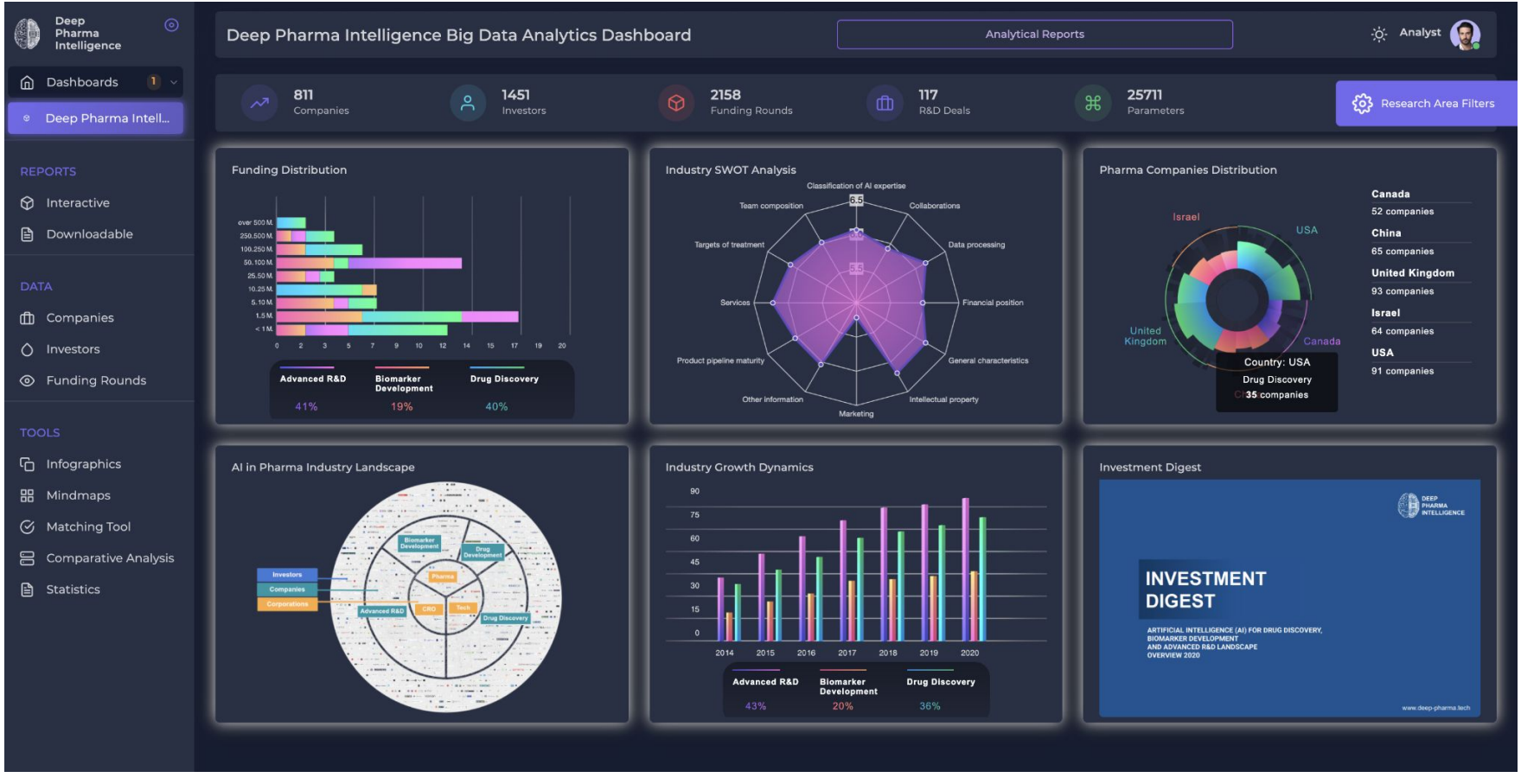
3D Visualisation Prototypes



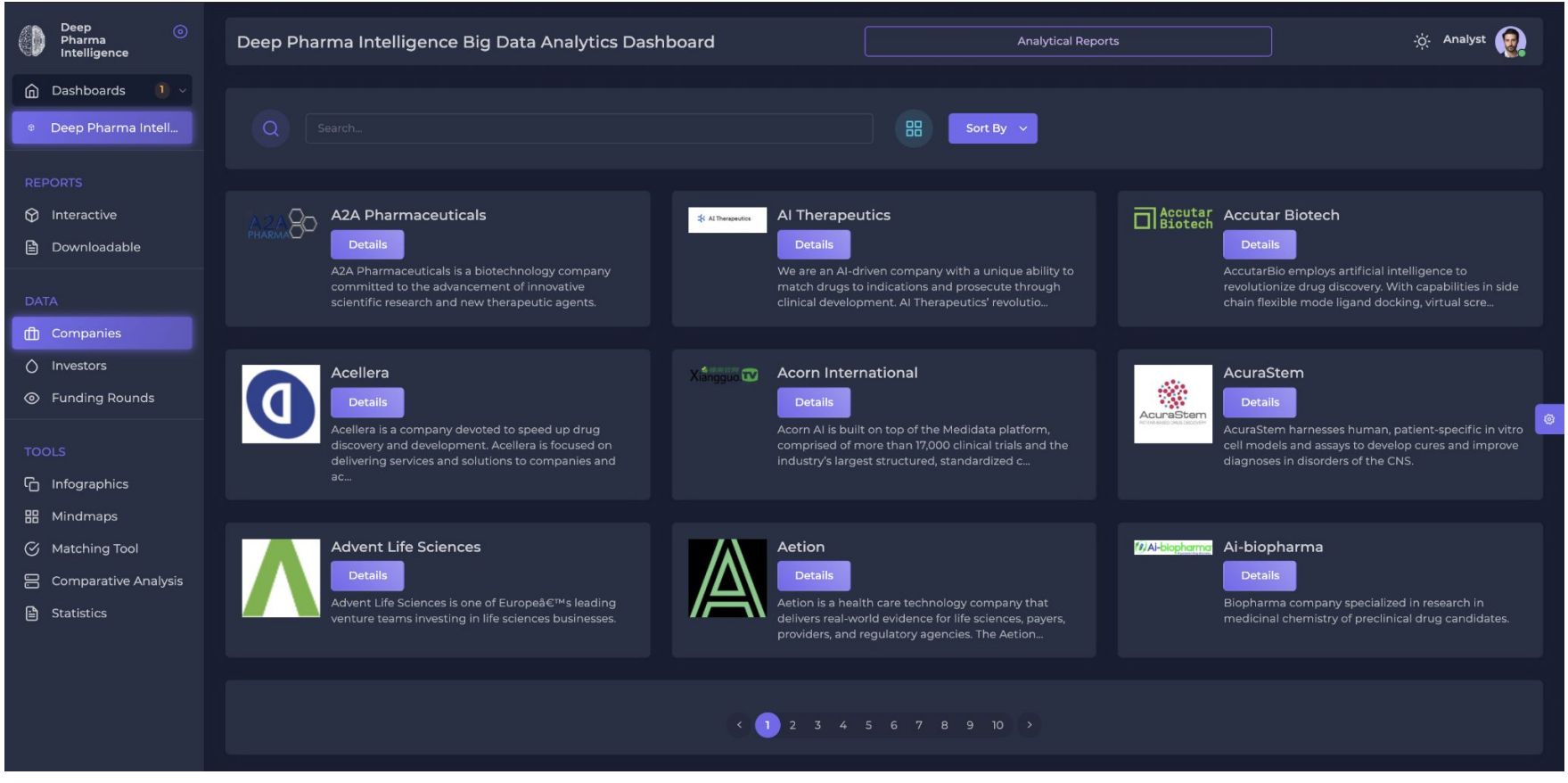


Visit Our Deep Pharma Intelligence Big Data Analytics Dashboard
platform.dkv.global/dashboards/ai-for-drug-discovery/

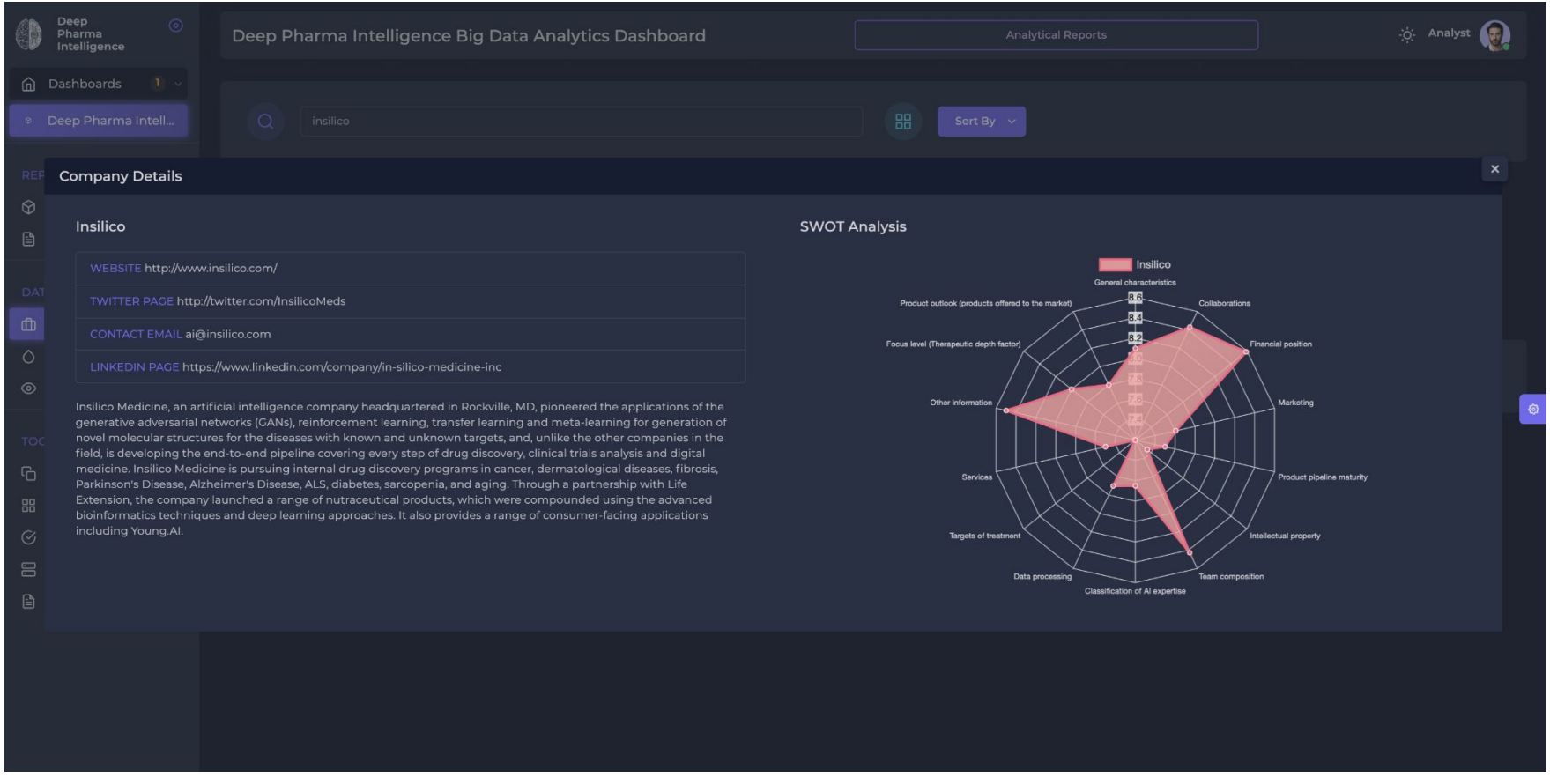
Deep Pharma Intelligence: Analytical Dashboard



Deep Pharma Intelligence: Analytical Dashboard

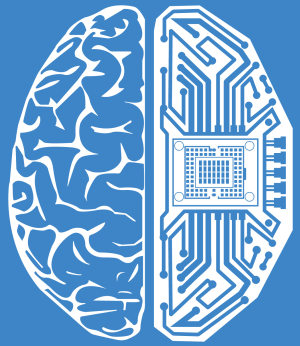


Deep Pharma Intelligence: Analytical Dashboard



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www.deep-pharma.tech



Link to the Report: deep-pharma.tech/landscape-overview-q2-2021	
E-mail: info@deep-pharma.tech	Website: deep-pharma.tech

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