

DEEP
PHARMA
INTELLIGENCE

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

Q4 2021



<https://www.deep-pharma.tech/>

Table of Contents

AI for Drug Discovery Infographic Summary and Mind Maps	3
Executive Summary	20
Application of AI for Advanced R&D	24
Business Activity: Key Trends	25
Industry developments: Challenges and Forecasts	26
Business Activity: Overview	30
Leading Companies by Amount and Stage of Funding	31
AI for Drug Discovery Market Timeline	36
50 Leading Investors in Pharmaceutical AI	36
Big Pharma's Focus on AI	46
AI in Pharma Publicly Traded Companies	54
Top Publicly Traded Companies Related to AI-Pharma	75
AI for Advanced R&D: Applications and Use Cases	89
Top AI Breakthroughs 2018-2021	90
Computational Methods Used by the Most Advanced AI Companies	94
25 Notable R&D Use Cases of AI Application in Biopharma	103
Industry Developments 2020-2021	155
Key Takeaways	166
Appendix: List of Entities	173
Overview of Proprietary Analytics by Deep Pharma Intelligence	203
Disclaimer	210

Introduction

This 210-page “**AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview Q4 2021**” report marks the tenth 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 occurred 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 Q4 2021

Preclinical Development

Clinical Development

AI Companies - 395
Investors - 1000
Corporations - 100

End-to-end Drug Development

Drug Repurposing

- AI Companies
- Investors
- Corporations

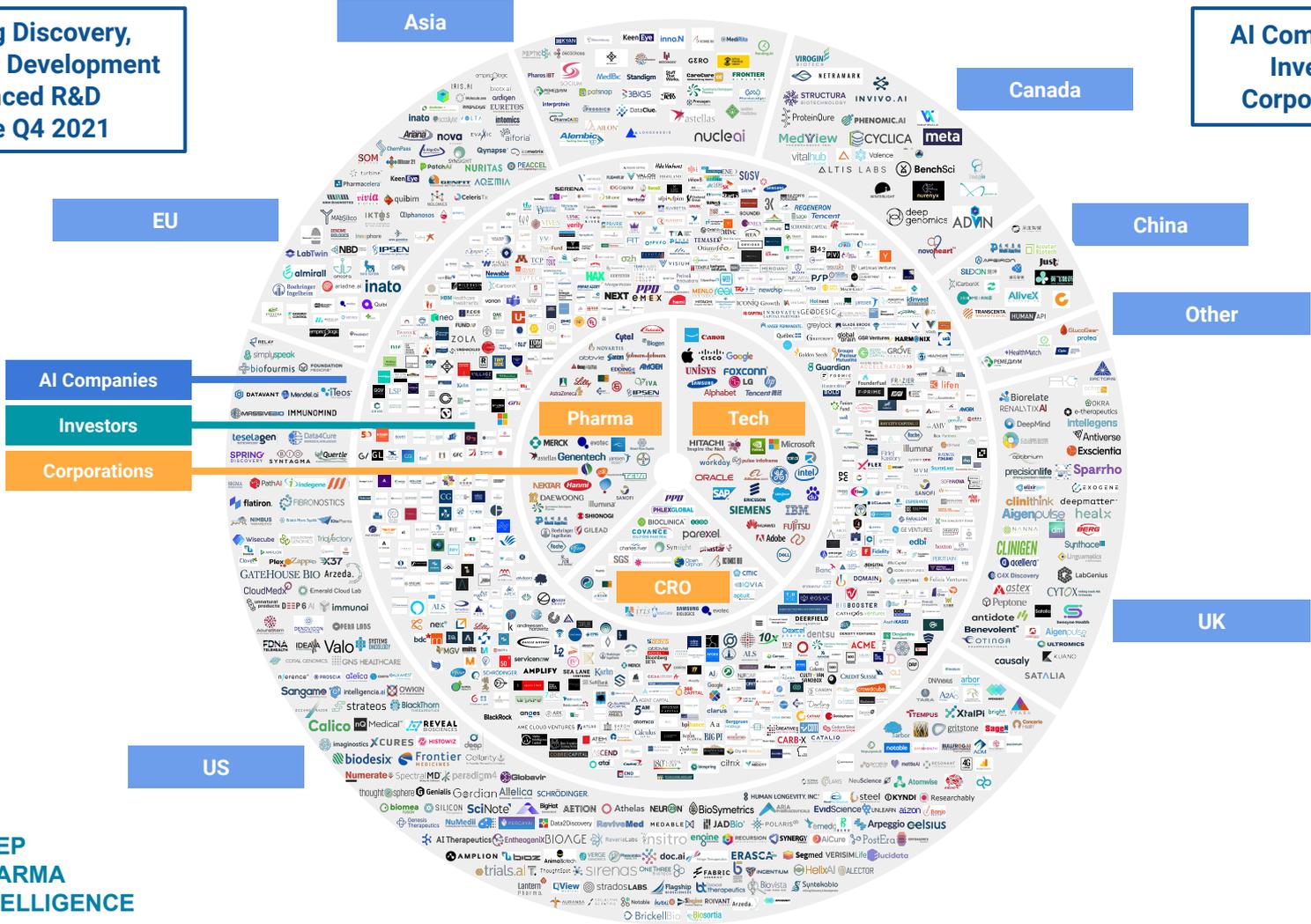


Data Processing

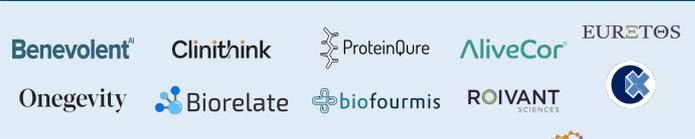


AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Q4 2021

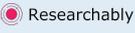
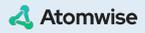
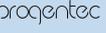
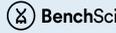
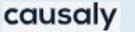
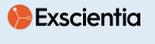
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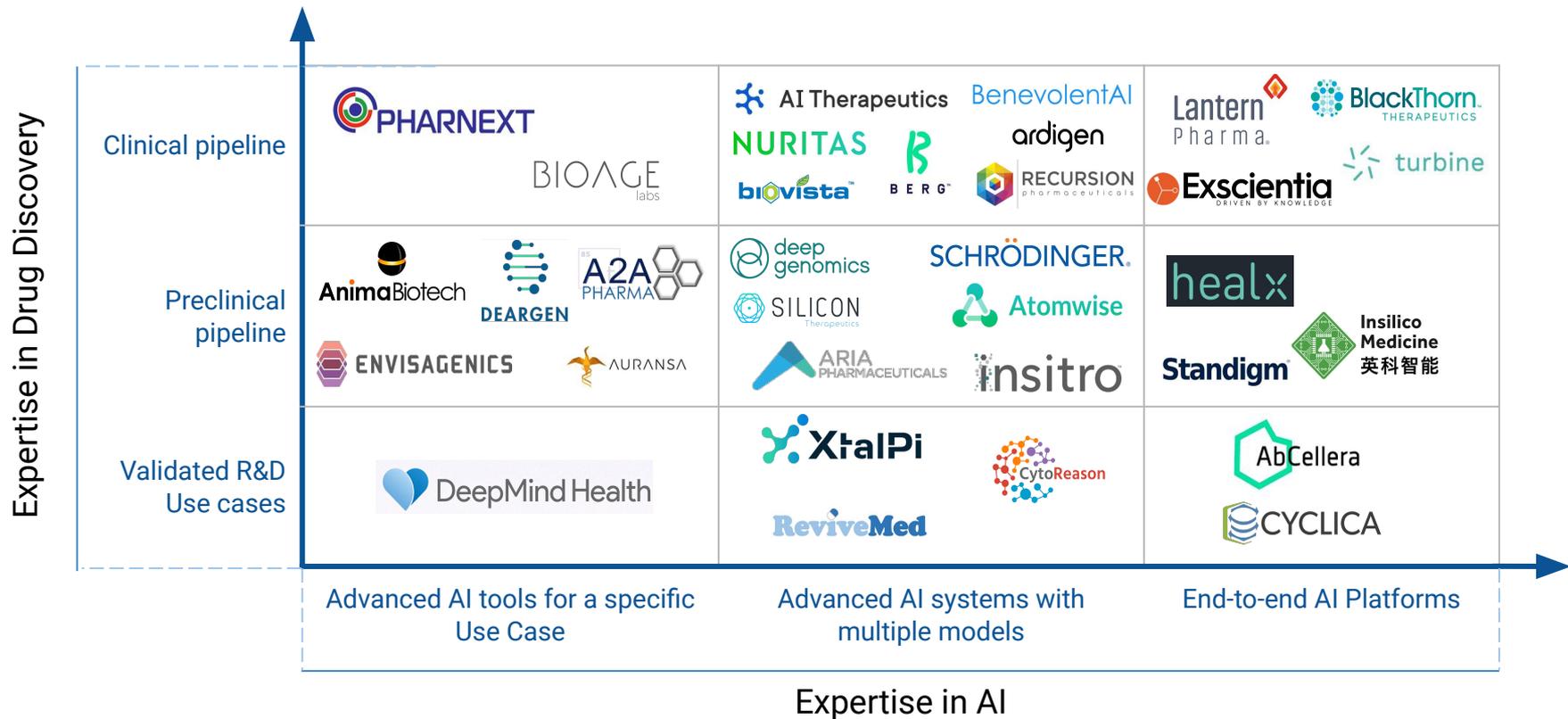
Selected Pharma AI Deals

AI Companies	Pharma Corporations	AI Companies
		
		
		
		
		
		

Selected Pharma AI Deals

AI Companies	Pharma Corporations	AI Companies
        	 	          
           	 	       
    	 	       
       	 	      
      	 	        
      	 	      

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	iCarbonX
13	Indegene
14	Insilico Medicine
15	Insitro

16	ITEOS Therapeutics
17	Nimbus Therapeutics
18	PathAI
19	PatSnap
20	Recursion Pharmaceuticals
21	Relay Therapeutics
22	Roivant Sciences
23	Schrödinger
24	SOPHiA GENETICS
25	Standigm
26	Synergy Pharmaceuticals
27	Tempus
28	ThoughtSpot
29	Valo Health
30	XtalPi

50 Leading Investors in AI for Drug Discovery Sector

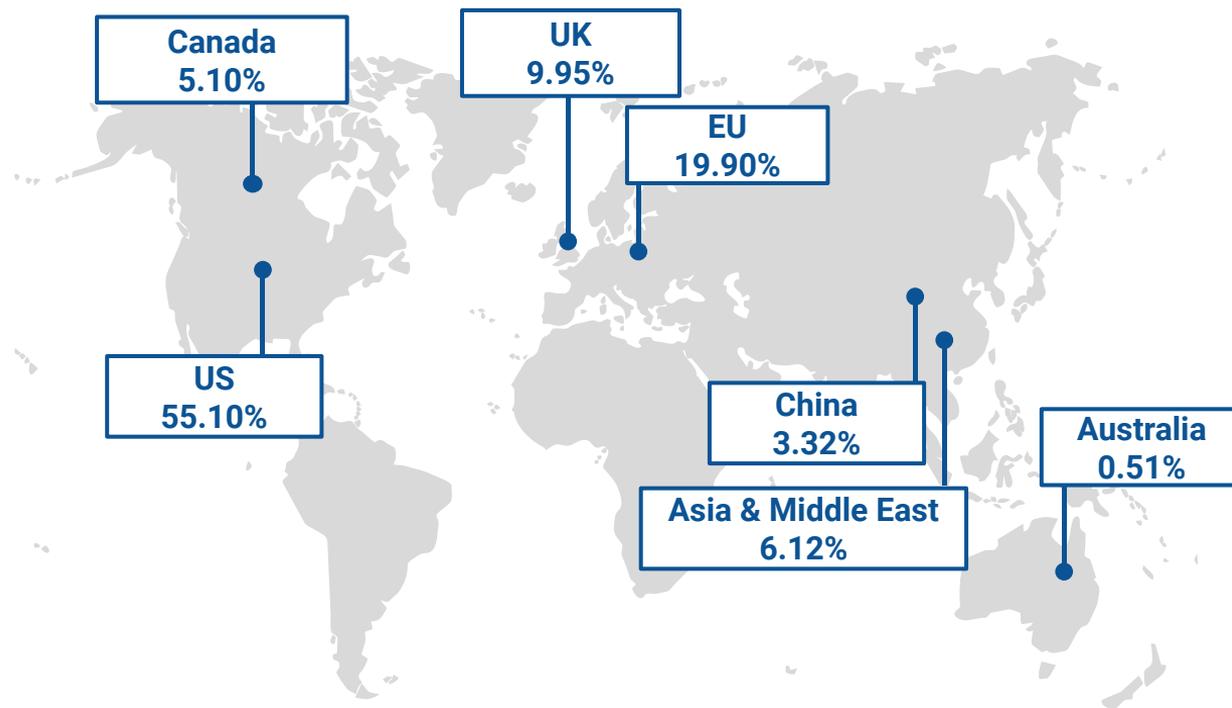
1	GV
2	Casdin Capital
3	DCVC
4	Y Combinator
5	Lux Capital
6	WuXi AppTec
7	Andreessen Horowitz
8	EASME - EU Executive Agency for SMEs
9	Lilly Asia Ventures
10	OS Fund
11	AME Cloud Ventures
12	ARCH Venture Partners
13	Felicis Ventures

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

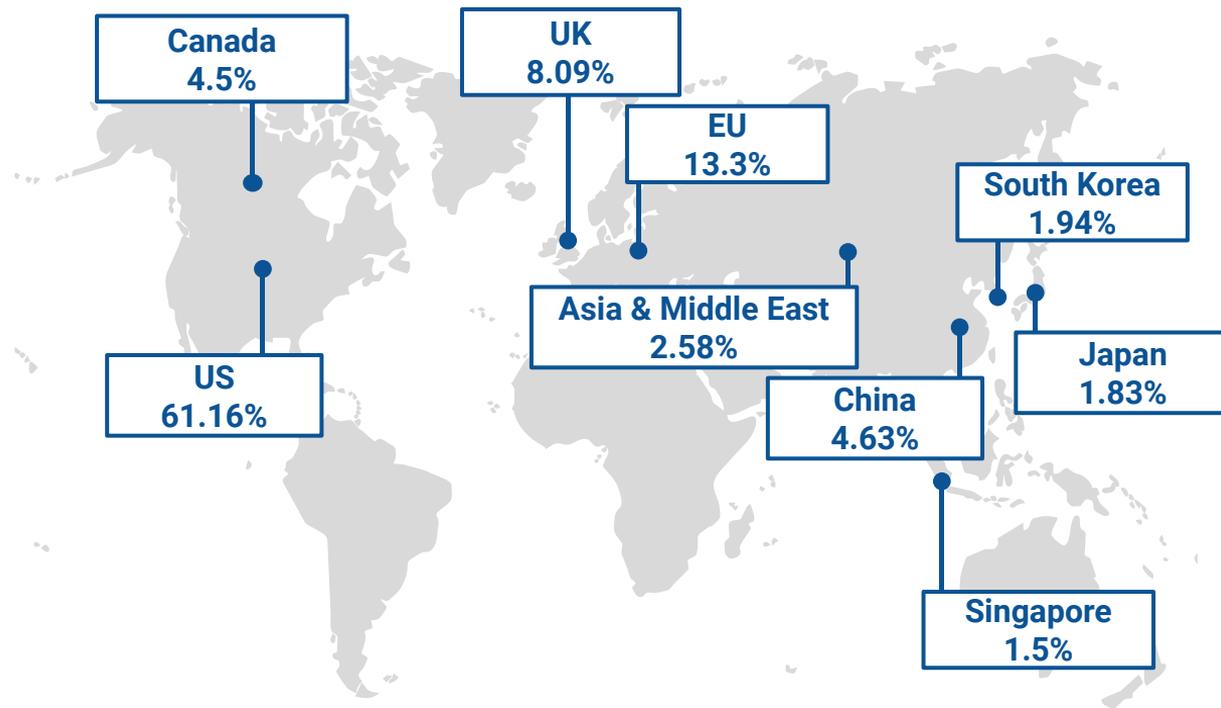
26	New Enterprise Associates	39	Bristol-Myers Squibb
27	Khosla Ventures	40	DCVC Bio
28	Perceptive Advisors	41	EPIC Ventures
29	SoftBank Vision Fund	42	GT Healthcare Capital Partners
30	Sequoia Capital China	43	Obvious Ventures
31	8VC	44	Lifeforce Capital
32	T. Rowe Price	45	Novo Holdings
33	6 Dimensions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

395 AI Companies: Regional Proportion



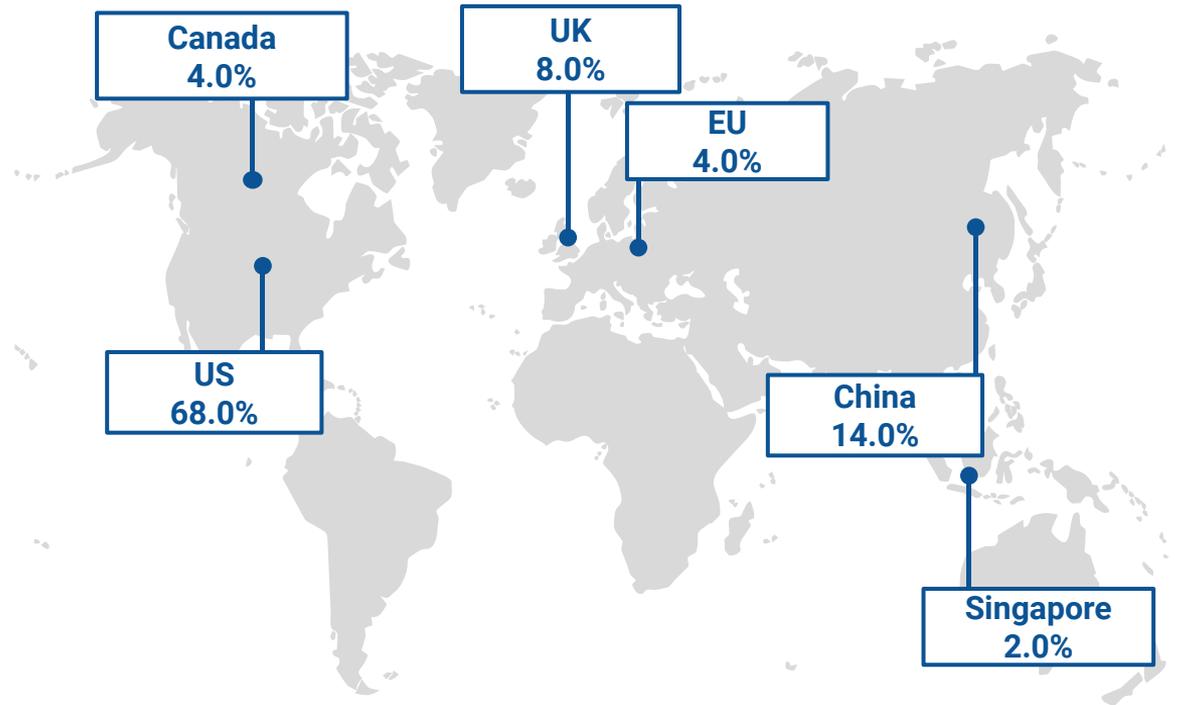
The US is still firmly in the lead in terms of its proportion of AI for Drug Discovery companies. Interestingly, Asia currently has the fourth-lowest proportion of AI for Drug Discovery companies. However, Asia-Pacific region has begun to aggressively increase its activity in the space in terms of investments 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.

1000 Investors: Regional Proportion



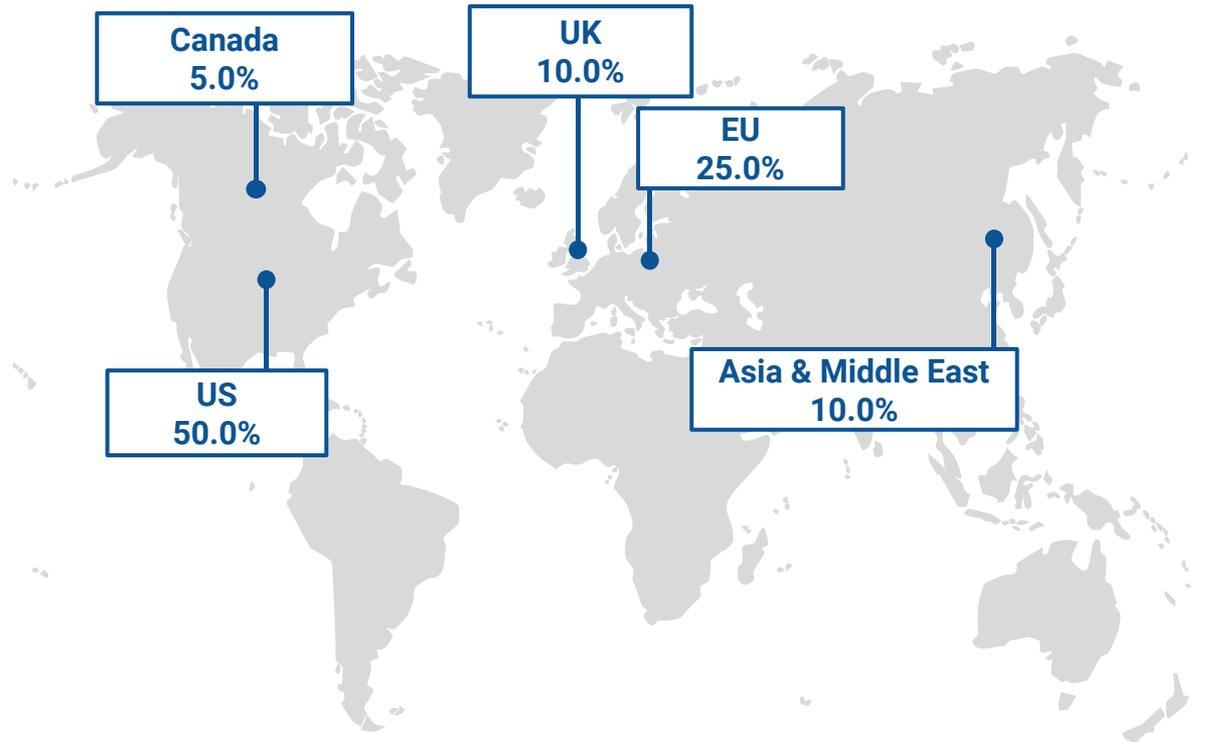
The United States continues to lead the rest of the world in terms of artificial intelligence for companies and funds that invest in Drug Discovery. This is reasonable, given that more than a half of the world's AI for Drug Discovery companies have their headquarters in USA. Comparing with previous periods 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



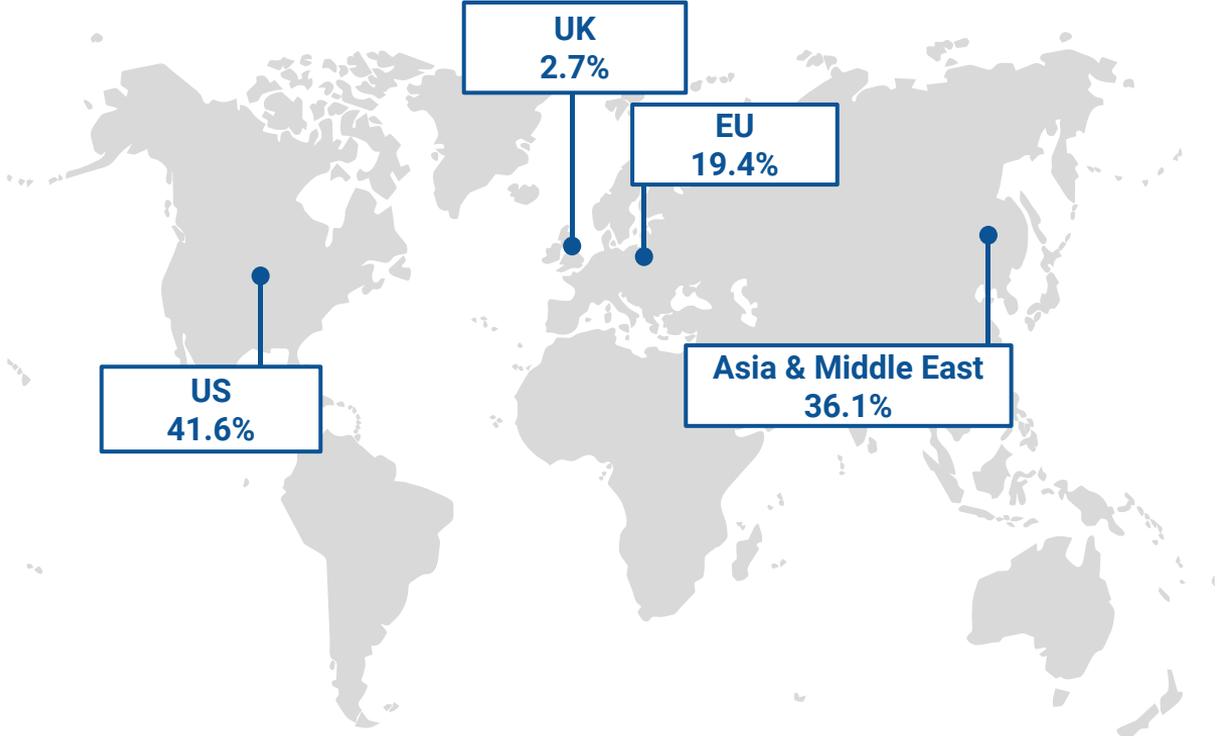
The United States continues to lead the rest of the world in terms of artificial intelligence for companies and funds that invest in Drug Discovery. This is reasonable, given that more than a half of the world's AI for Drug Discovery companies have their headquarters in USA. During Q1-Q2 2021 we can observe significant growth of the number of investors in Asia, mainly in China, Hong Kong and Singapore. The USA, the UK, Canada and EU remain to be leaders by the number of investors in AI in Pharma companies.

20 CROs: Regional Proportion



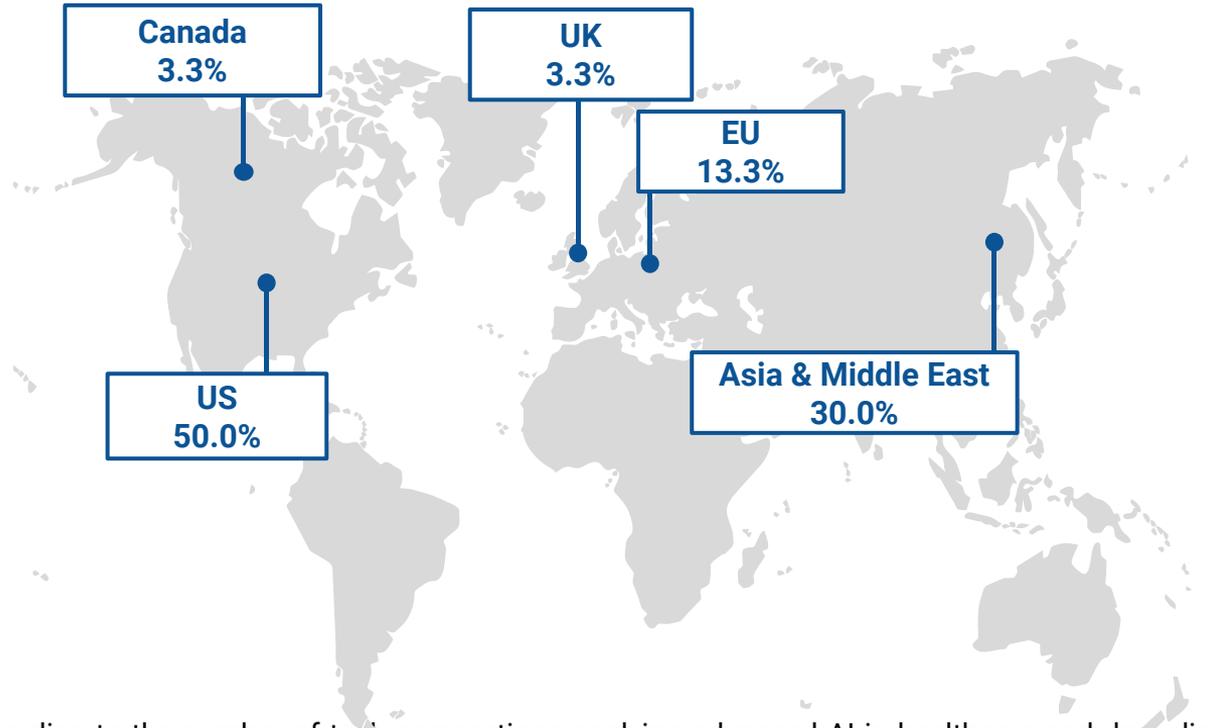
The United States leads the AI race on the level of Contract Research Organizations as well, with 50.0% of CROs being based in the US. It is followed by the European Union with 25.0%. The other 10.0% have their headquarters in the UK. Asia also represents 10.00% of the AI-interested CROs, which would probably increase in the following years due to Chinese strategy on AI implementation and large investments in the AI industry.

36 Pharma Corporations Applying Advanced AI in Healthcare and Drug Discovery



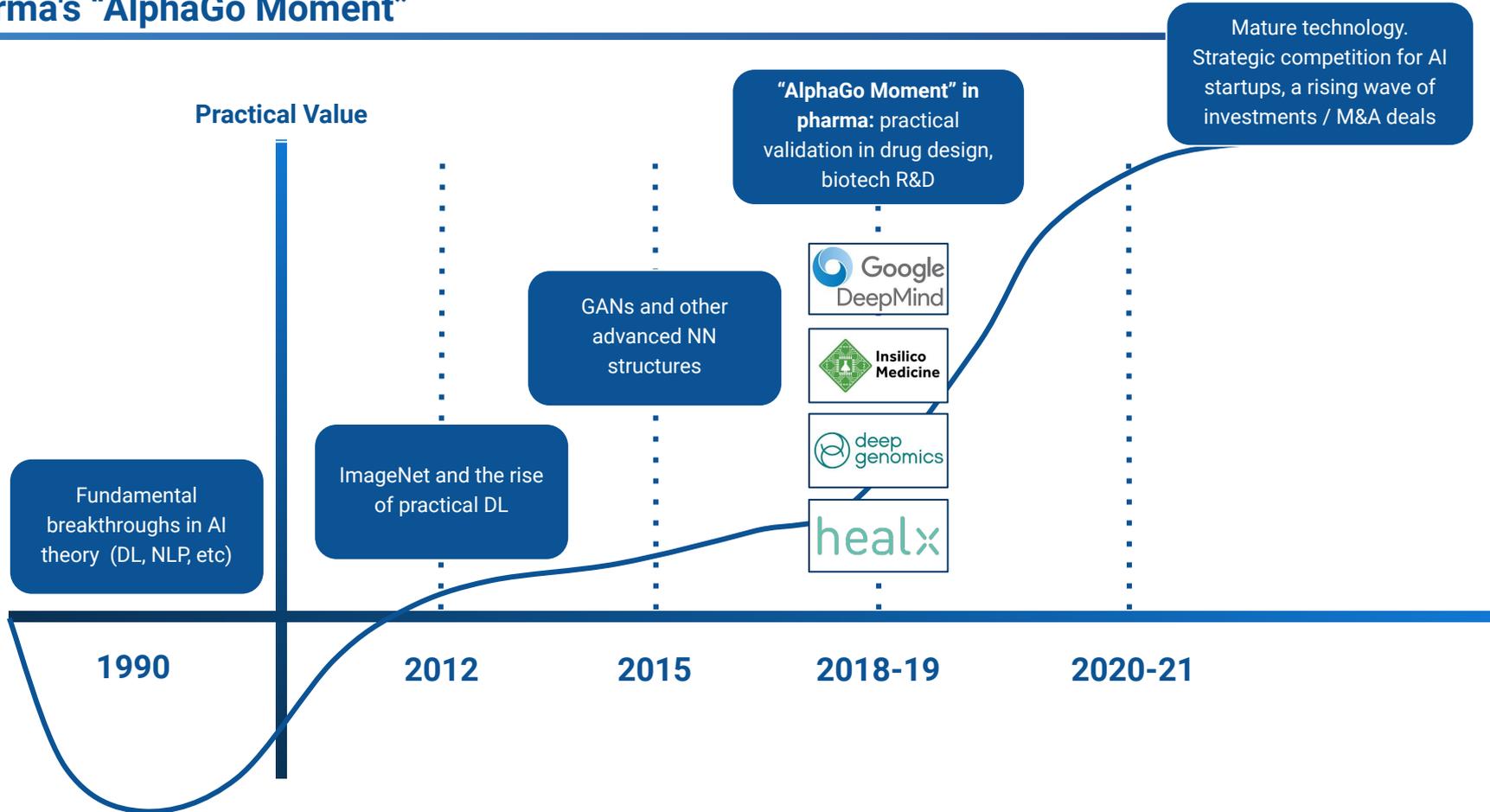
The industry is seeing an increasing level of regional diversification. Whereas historically the US has dominated the AI for Drug Discovery race in terms of the number of AI companies, the volume of investments and number of industry specialized conferences, from 2019 we are seeing an increased level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

30 Leading Tech 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 overweighs 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"





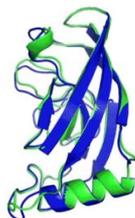
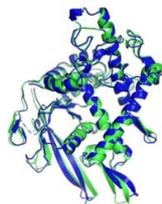
Deep Genomics AI-driven platform predicted novel target and oligonucleotide candidate for Wilson disease in under 18 months.

2019



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

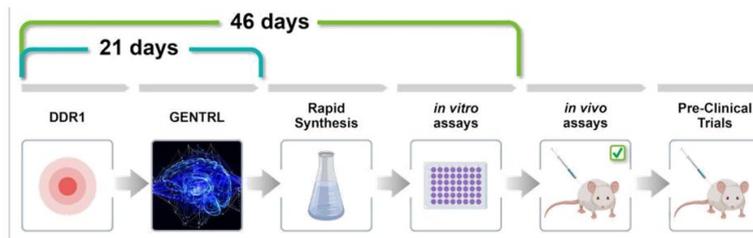
2020



■ Experimental Result
■ Computational Prediction

2019

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



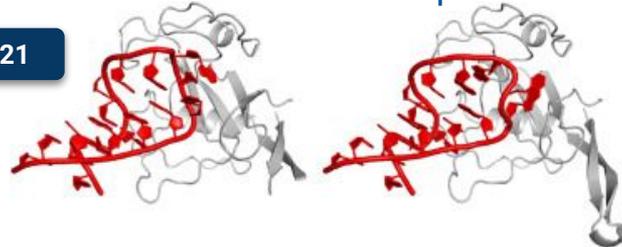
The University of Washington has developed a deep learning model, "**RoseTTAFold**", that calculates protein structure on a single gaming computer within 10 minutes.



2021

Model

Experiment



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

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.



Executive Summary



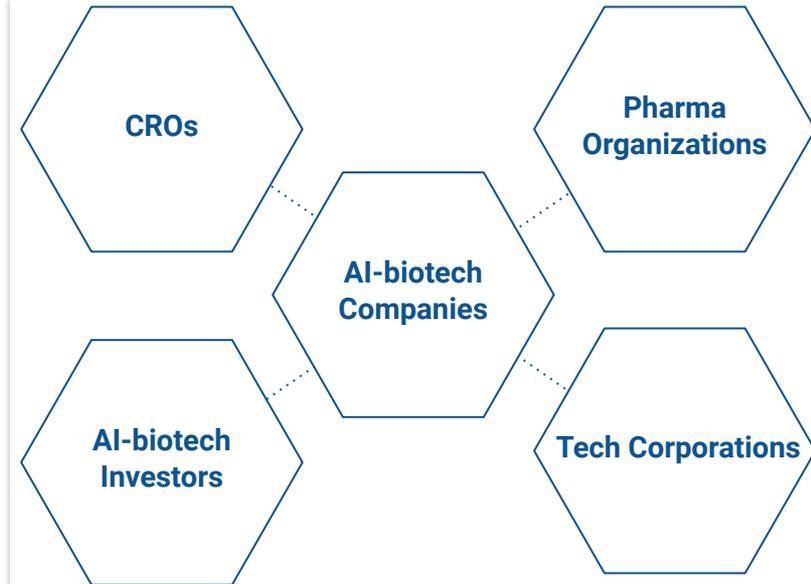
This Report at a Glance

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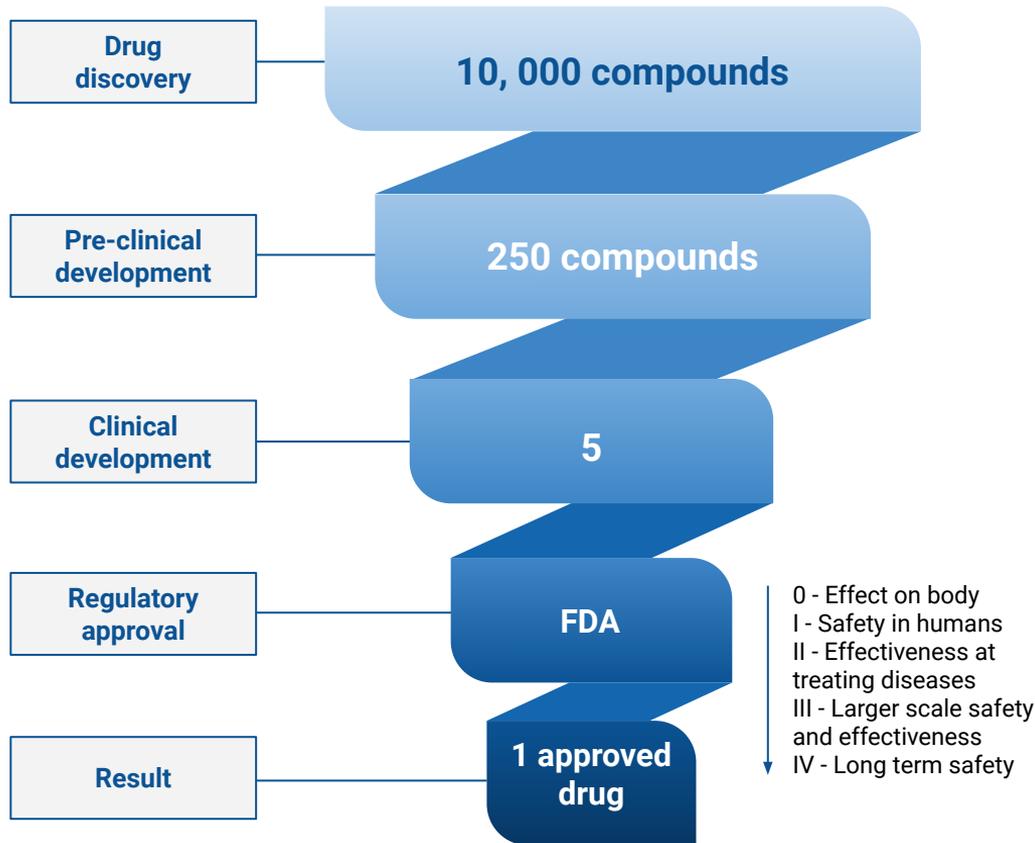
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Alongside investment and business trends, the report also provides technical insights into some of the latest achievements in the AI application and research.



This report has been put together taking into account the unprecedented global **COVID19 pandemics**. COVID19 brought about quite a few opportunities for the drug makers, but it also created many major challenges. 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:

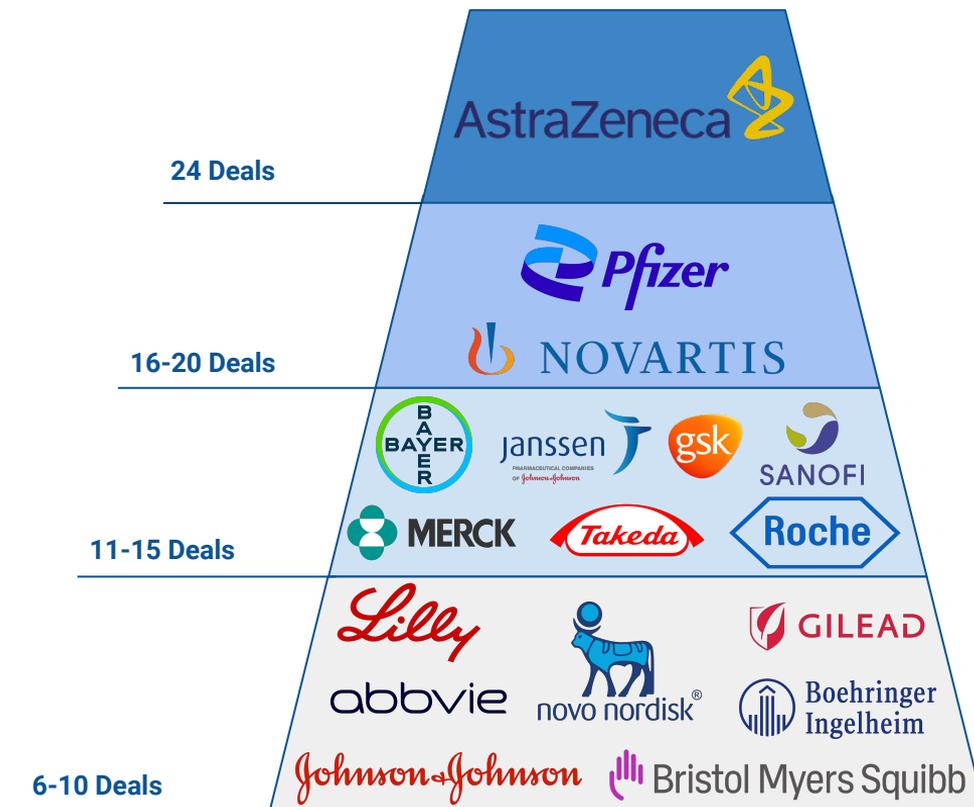
- evolution of business models towards more collaboration and pipeline diversification early
- implementation of AI as a universal shift towards data-centric drug discovery
- discovery of new therapeutic modalities (biologics, therapies etc.)

Big Pharmas' AI-focused partnerships in Q3-Q4 2021

In this report we have profiled 395 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-Q4 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 to increase 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
- **AstraZeneca, Merck, Pfizer** and **Teva** formed **AION Labs**, the innovative lab that will create and adopt **AI technology** to **transform the process of drug discovery**

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-Q4 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.

AI on different steps in DD

AI is used not only for drug design, but also target identification

AI platforms yield successful results

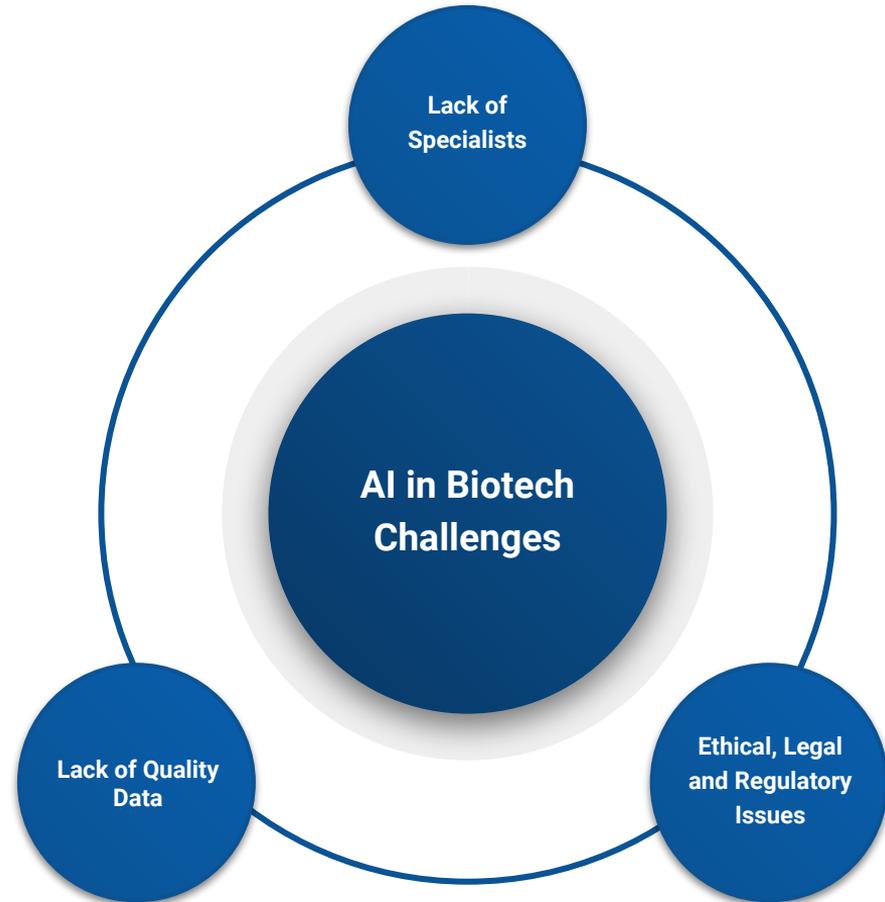
Many AI-designed drugs showed successful results in research studies and even clinical trials

AI democratizations

Ready-to-use AI platforms for DD became available and can be used by non-AI experts

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

Europe has traditionally been a strong breeding ground for biopharma activity

The UK and EU activity in the pharmaceutical AI race is mainly boosted by **Novartis**. UK-based **BenevolentAI** and **AstraZeneca** collaborate with novel AI-generated chronic kidney disease target.

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.

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.

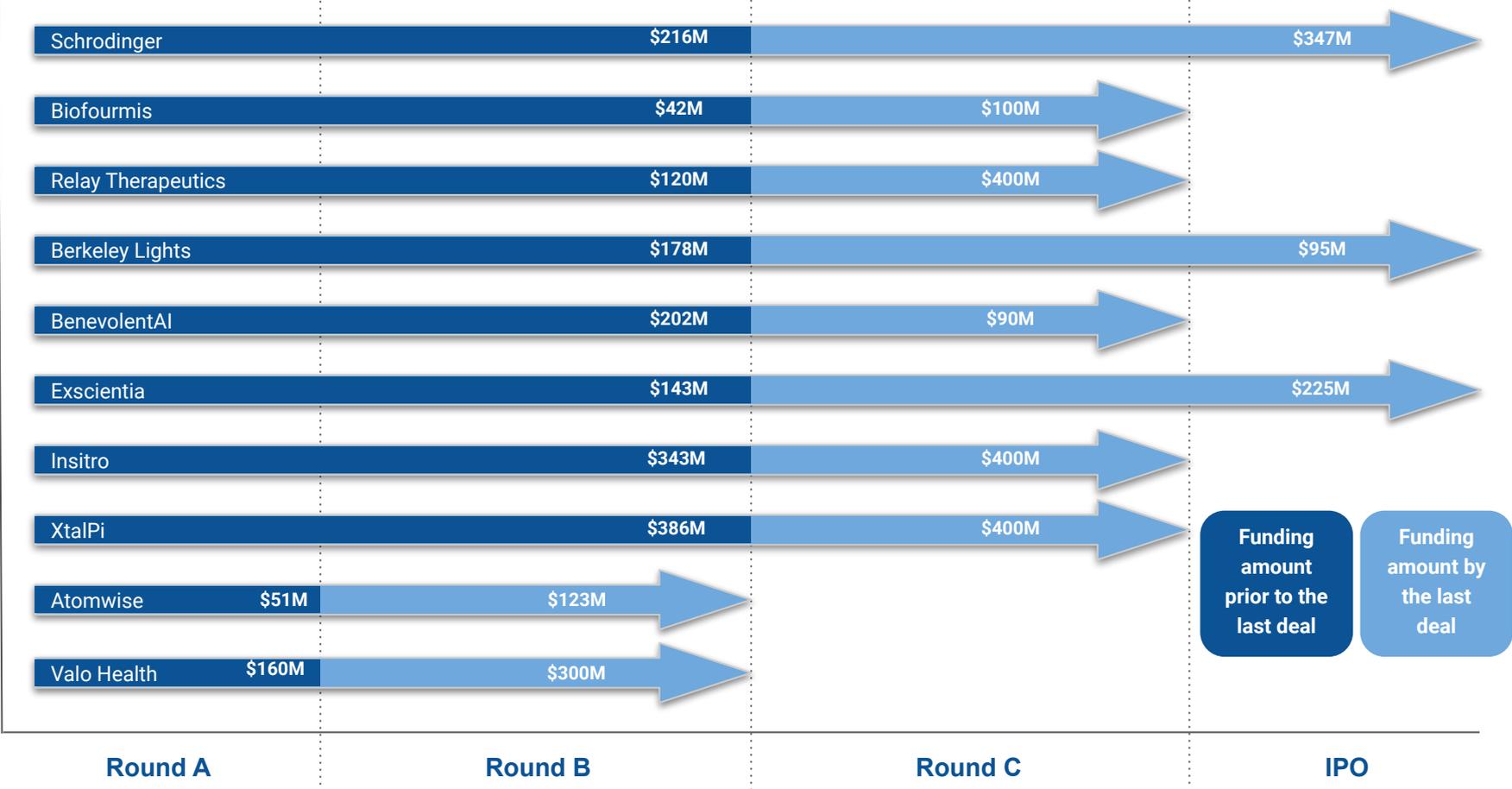
China plans to become the world AI leader by 2030

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.

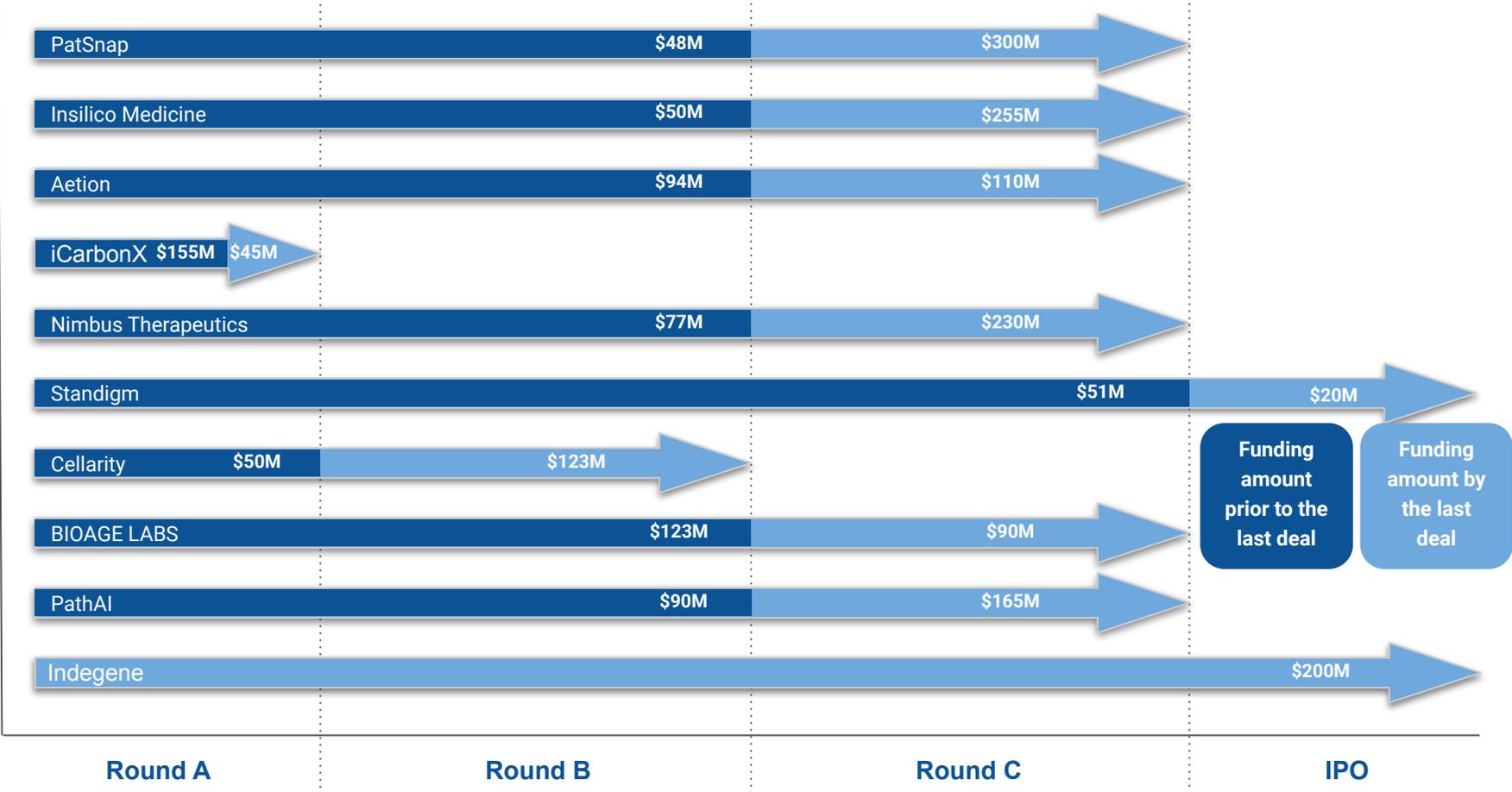
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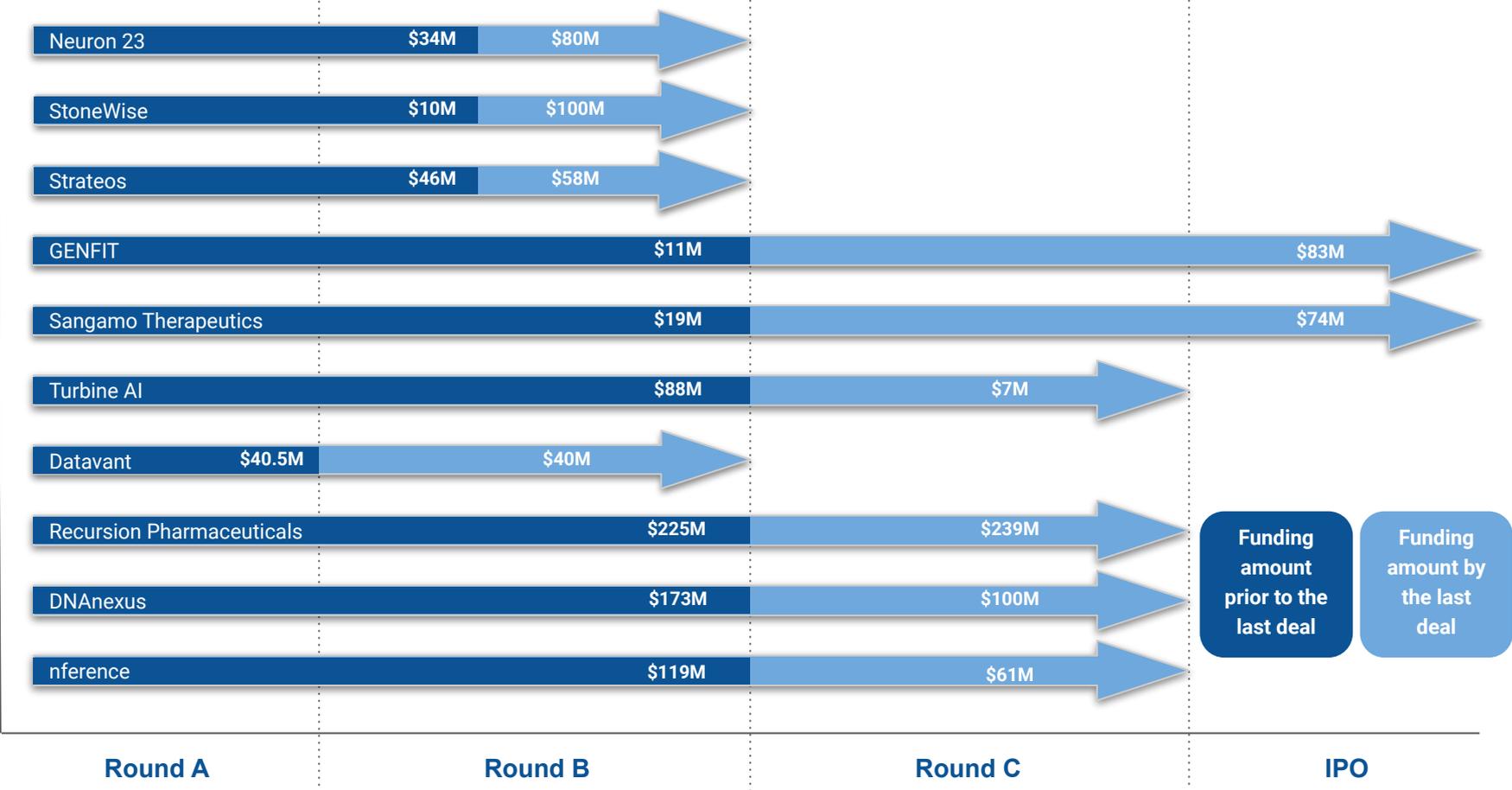
Leading Companies by Amount and Stage of Funding



Leading Companies by Amount and Stage of Funding



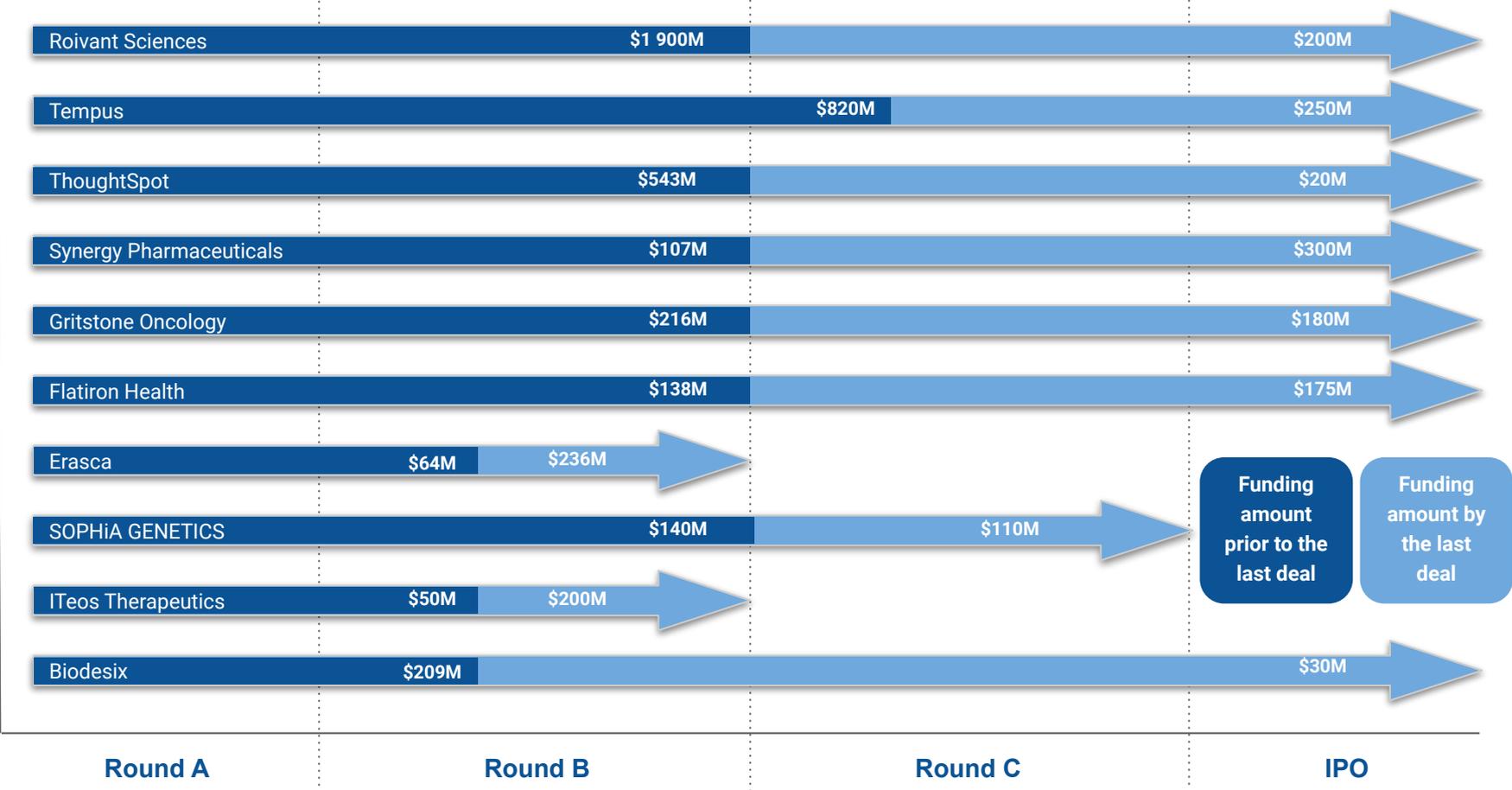
Leading Companies by Amount and Stage of Funding



Funding amount prior to the last deal

Funding amount by the last deal

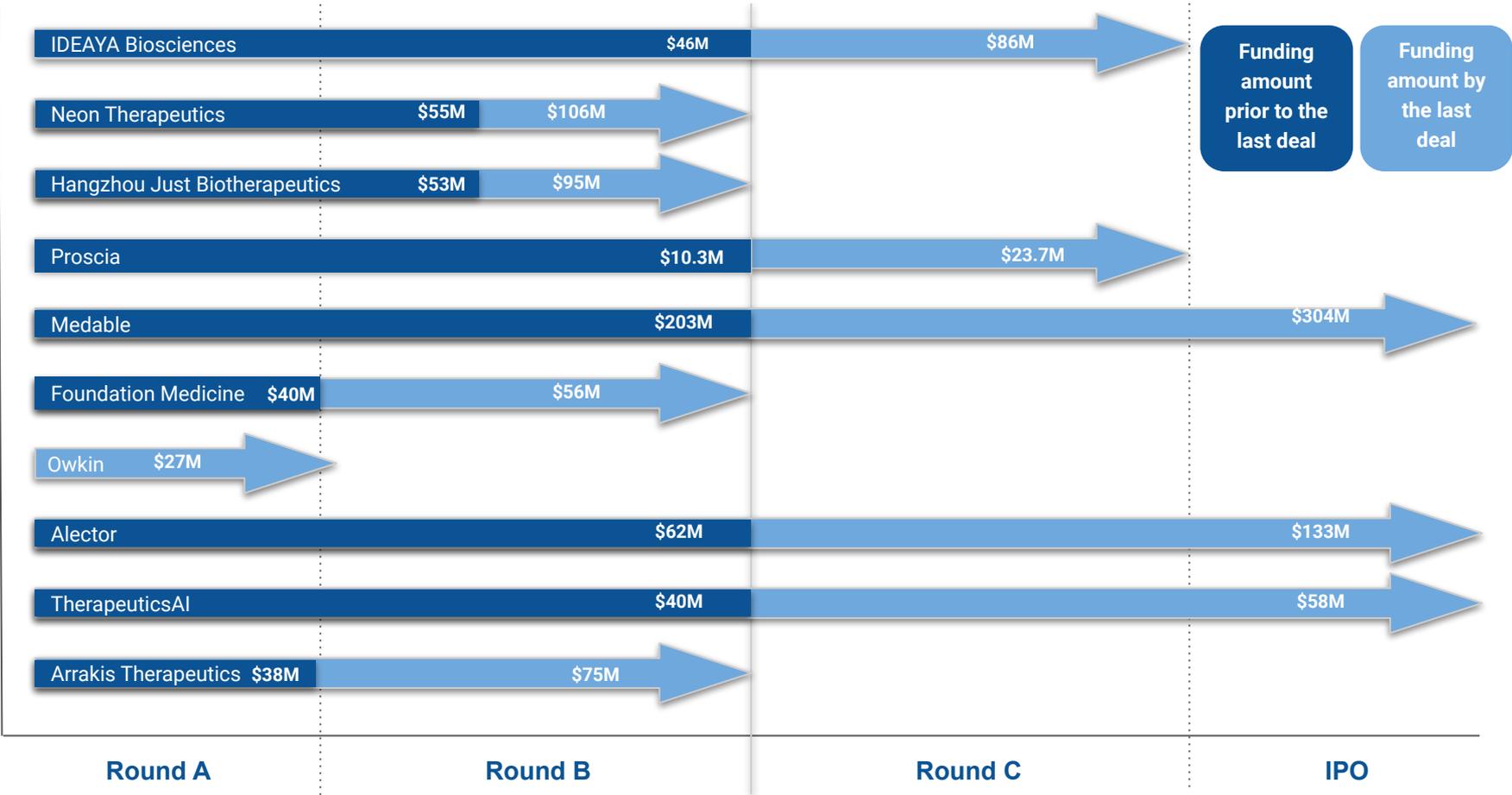
Leading Companies by Amount and Stage of Funding



Funding amount prior to the last deal

Funding amount by the last deal

Leading Companies by Amount and Stage of Funding



AI for Drug Discovery Market Timeline

The First AI Approaches

- 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

- 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

- 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

- 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

- 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

- 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.

2013-2015

2016-2017

2018

2019

2020-2021

2022-2023

50 Leading Investors in Pharmaceutical AI



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

Top-50 AI in Pharma Investors



San Francisco

8VC
San Francisco, California, US

Founders Fund
San Francisco, California, US

Foresite Capital
San Francisco, California, US

DCVC
San Francisco, California, US

Alexandria Venture
San Francisco, California, US

Obvious Ventures
San Francisco, California, US

Lifeforce Capital
San Francisco, California, US

DCVC Bio
San Francisco, California, US

Mountain View

Y Combinator
Mountain View, California, US

GV
Mountain View, California, US

Palo Alto

AME Cloud Ventures
Palo Alto, California, US

Alexandria Venture Investments
Pasadena, California, US

New York

OrbiMed
New York, New York, US

Bristol-Myers Squibb
New York, New York, US

Perceptive Advisors
New York, New York, US

Lux Capital
New York, New York, US

Two Sigma Ventures
New York, New York, US

Casdin Capital
New York, New York, US

Menlo Park

New Enterprise Associates
Menlo Park, California, US

Andressen Horowitz
Menlo Park, California, US

Felicis Ventures
Menlo Park, California, US

Khosla Ventures
Menlo Park, California, US

Illinois

OS Fund
Park Ridge, Illinois, US

ARCH Venture Partners
Chicago, Illinois, US

Other States

Bill & Melinda Gates Foundation
Seattle, Washington, US

Lili Ventures
Indianapolis, Indiana, US

SOSV
Princeton, New Jersey, US

Celgene
Summit, New Jersey, US

T. Rowe Price
Baltimore, Maryland, US

Revolution
Washington, District of Columbia, US

EPIC Ventures
Salt Lake City, Utah, US

Massachusetts

General Catalyst
Cambridge, Massachusetts, US

SR One
Cambridge, Massachusetts, US

Third Rock Ventures
Boston, Massachusetts, US

F-Prime Capital
Cambridge, Massachusetts, US

Manhattan Beach

B Capital Group
Manhattan Beach, California, US



Inovia Capital
Montréal, Québec, Canada



EASME
Brussels, Brussels
Hoofdstedelijk Gewest,
Belgium



Novo Holdings
Hellerup, Hovedstaden,
Denmark



EDBI
Singapore, Central Region



SoftBank Vision Fund
London, England, The UK

Amadeus Capital Partners
London, England, The UK



Beijing

ZhenFund
Beijing, China

Baidu Ventures
Beijing, China

Sequoia Capital China
Beijing, China

Shanghai

WuXi AppTec
Shanghai, China

Lilly Asia Ventures
Shanghai, China

6 Dimensions Capital
Shanghai, China

GT Healthcare Capital Partners
Central, Hong Kong Island,
Hong Kong

Baillie Gifford
Edinburgh, Edinburgh, The UK

Octopus Ventures
London, England, The UK

Top-50 Investors in AI Companies

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

Top-50 Investors in AI Companies

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

Top-50 Investors in AI Companies

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

Top-50 Investors in AI Companies

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

Top-50 Investors in AI Companies

INVESTORS	INVESTMENTS OVERALL	AI FOR DRUG DISCOVERY COMPANIES	INVESTMENTS OVERALL
 SOSV	7	3	A2A Pharmaceuticals, Mendel.ai, Synthace
 T. Rowe Price	6	3	Genesis Therapeutics, Insitro, Tempus
 Two Sigma Ventures	6	3	Exscientia, PathAI
 Amgen Ventures	4	3	Action, Alector, GNS Healthcare
 Novo Holdings	5	2	Exscientia, Tempus
 Octopus Ventures	5	2	Antidote.me, GTN
 Revolution	5	2	Amplion, Tempus
 Bristol-Myers Squibb	4	2	Exscientia, PathAI
 New Enterprise Associates	6	2	Action, Tempus
 EPIC Ventures	5	1	Recursion Pharmaceuticals

Big Pharma's Focus on AI



AI and Pharma Collaborations in 2021


PHILIPS
Merck and Philips partner to advance **AI-based personalized fertility treatment**


Pfizer
Pfizer's small-molecule programs will apply **Iktos'** AI-driven de novo design software.


Exscientia
Exscientia has signed up **BMS** for its **AI-based drug discovery platform**. The value of a deal could be as much as \$1.2 billion.


teva
Insilico Medicine entered into a collaboration with **Teva** to utilize Insilico's machine learning technology.


SPI
Japan's **Summit Pharmaceuticals International (SPI)** partners with **CytoReason** to integrate its **machine learning platform** into the Japanese **clinical drug discovery sector**.

Jan

Feb

Mar

Apr

May

Jun

Jun

Aug

Sep

Oct

Roche Italia has joined forces with **PatchAi** to launch a **virtual platform for cancer patients**.



AstraZeneca is teamed up with **NVIDIA** and the **University of Florida** on new **AI research projects** aimed at boosting drug discovery and patient care.



GSK announced an 18-month collaborative research agreement with AI company **Progentec**.



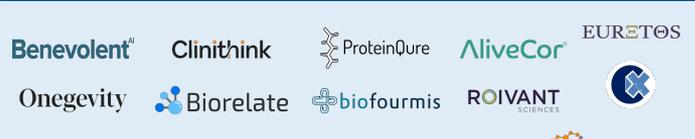
Insilico Medicine and **Westlake Pharma** announce cooperation relationship on accelerating the innovative drugs R&D for novel coronavirus.



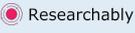
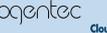
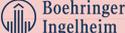
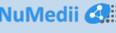
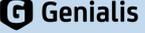
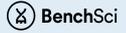
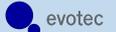
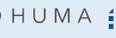
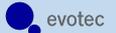
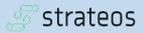
Poolbeg Pharma launches AI programme with **Eurofins Genomics**.



Selected Pharma AI Deals

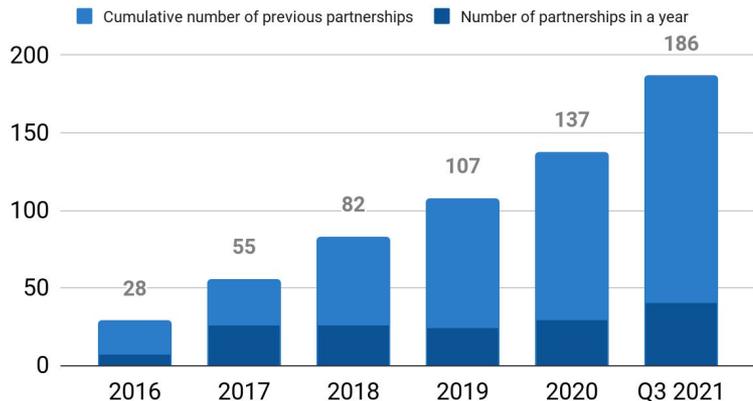
AI Companies	Pharma Corporations	AI Companies
		
		
		
		
		
		

Selected Pharma AI Deals

AI Companies	Pharma Corporations	AI Companies
        	 	          
           	 	       
    	 	       
       	 	      
      	 	         
      	 	      

A Growing Number of Collaborations Involving AI for Drug Discovery

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.

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 cautious 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.

Corporation and AI-companies Participating in the Pharma AI Deals

Pharma Partners



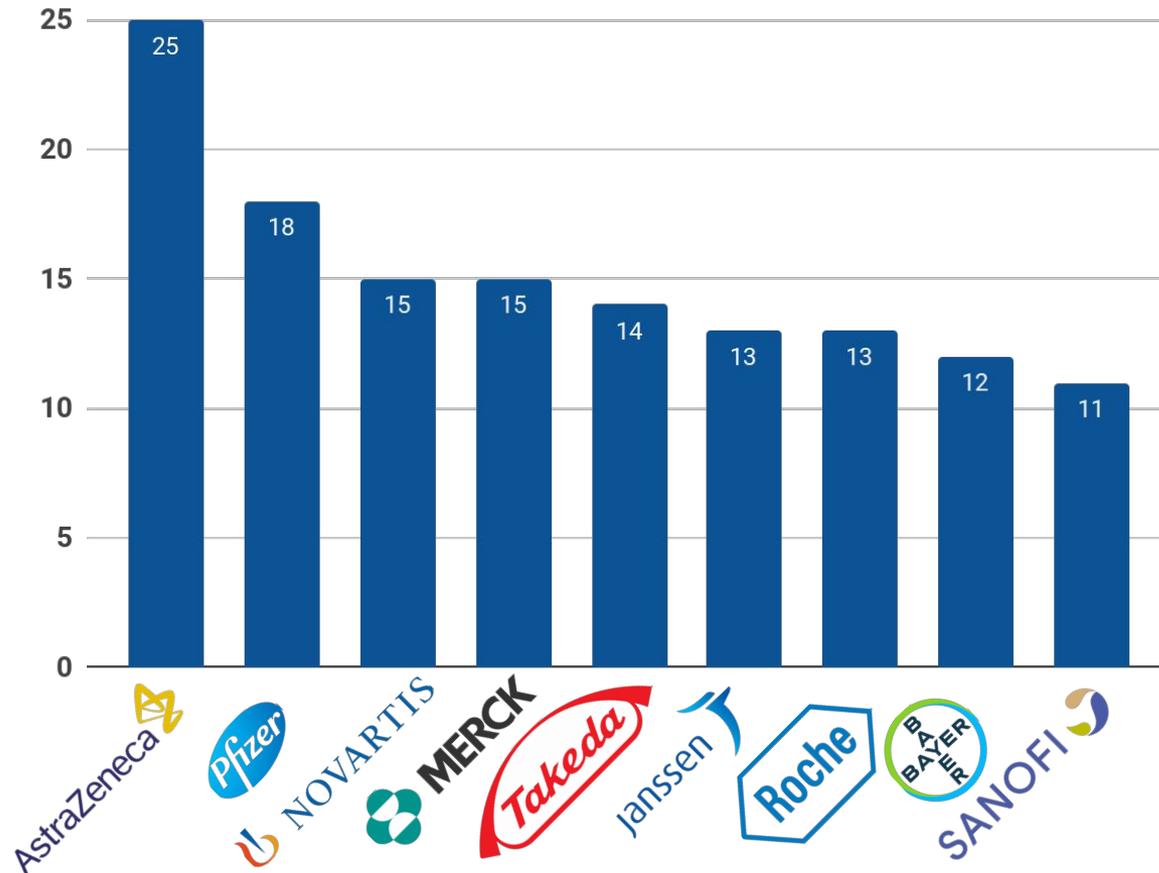
AI and Biotech Partners



Tech Partners



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 **Pfizer**.

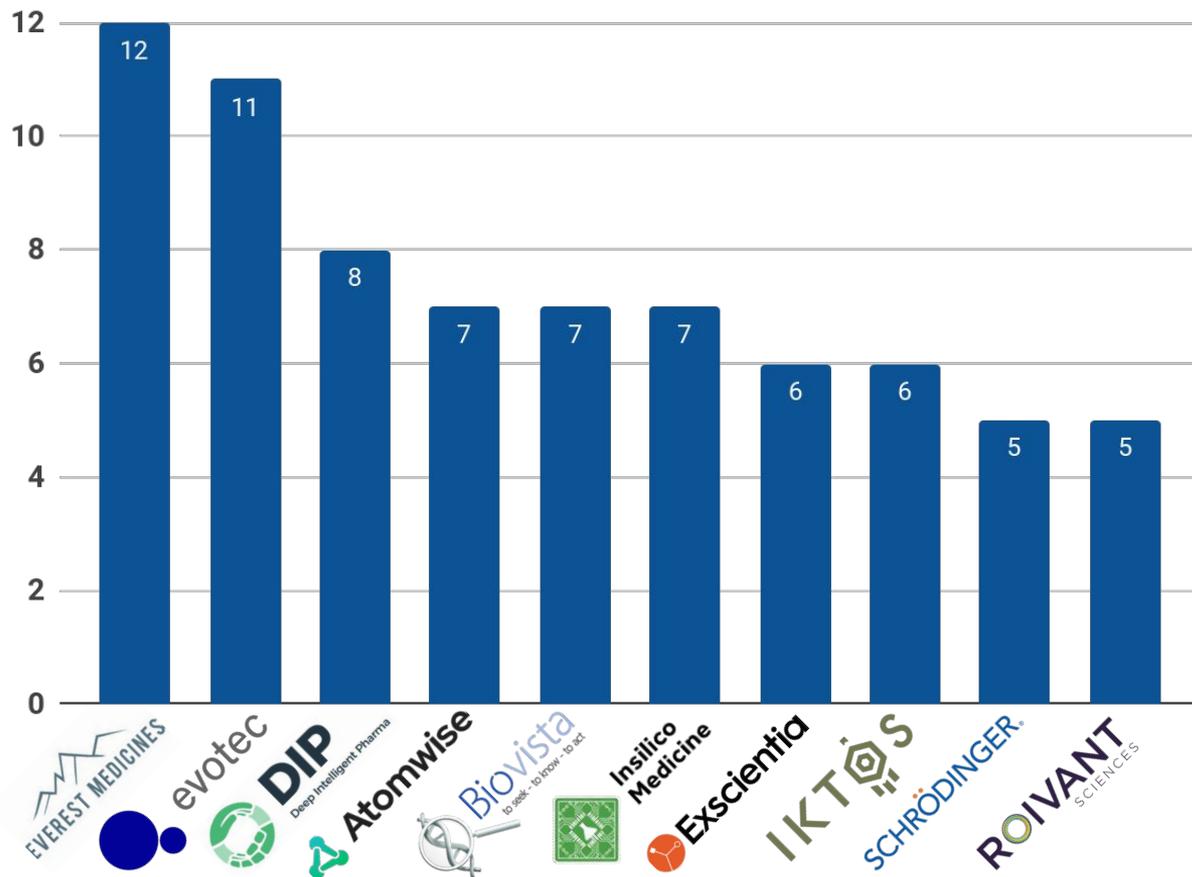
Implications

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 **Everest Medicines, Evotec and Deep Intelligent Pharma.**

Implications

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

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



DEEP
PHARMA
INTELLIGENCE



AI in Pharma Publicly Traded Companies



Connecticut

 BioXcel Therapeutics (BX2)
Branford, Connecticut, US

Massachusetts

 Relay Therapeutics (RLAY)
Cambridge, Massachusetts, US

 ITEOS Therapeutics (ITOS)
Cambridge, Massachusetts, US

Colorado

 Biosesix (BDSX)
Broomfield, Colorado, US

 Evolutionary Genomics (FNAM)
Lafayette, Colorado, US

Texas & Utah

 Lantern Pharma (LTRN)
Dallas, Texas, US

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

New York

 Schrödinger (SDGR)
New York, New York, 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



Nord-Pas-de-Calais

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



Hong-Kong

 Regent Pacific Group
Hong-Kong

 Deep Longevity
Acquired for \$4M by
Regent Pacific Group



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

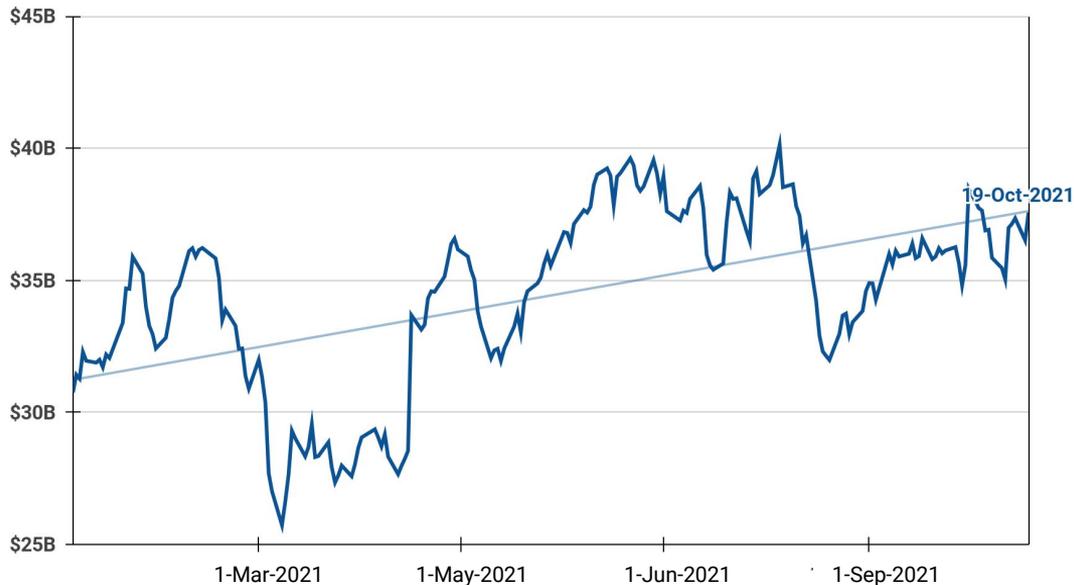
 eTherapeutics (ETX.L)
Hanborough, Oxfordshire, UK

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

 RENALYTIX AI (RENX)
Penarth, Oxfordshire, UK

AI in Pharma Publicly Traded Companies

Cumulative Capitalization of Publicly Traded AI-in-Pharma Discovery Companies, 2021, \$ Billion



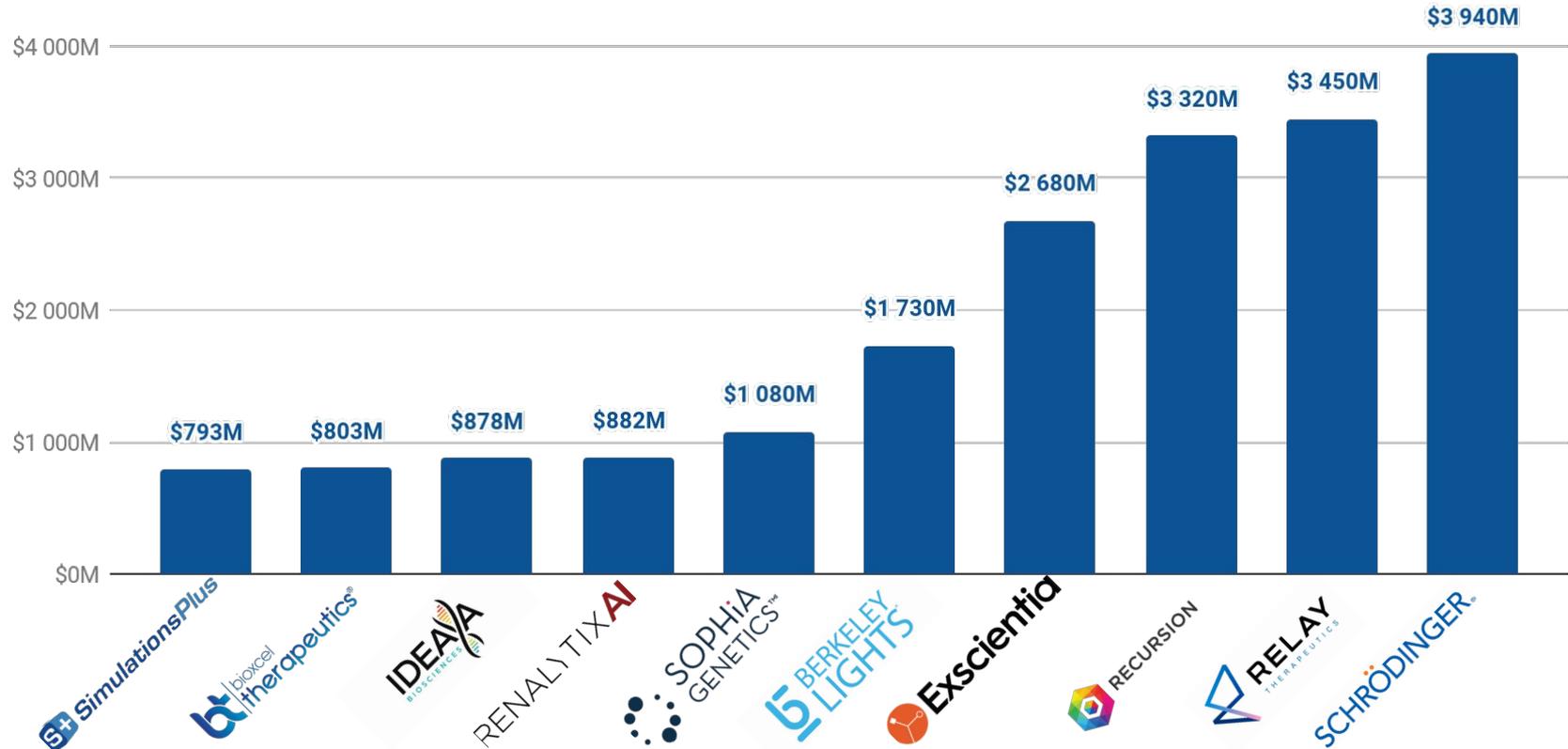
Despite the crisis and high volatility, AI-in-Pharma publicly traded companies present growth **reaching \$38.3B of cumulative capitalization as of October, 20 2021**. Five companies from our list have announced closing of IPO during Q2-Q3 2021: **Evaxion Biotech, Biomea Fusion, Recursion Pharmaceuticals, Erasca and SOPHIA GENETICS**.

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

There was a significant decline of stock prices during Q1-Q3 2021. The reason is that established companies with products on the market generating lower profitability than expected due to higher than expected raw material, employee and other expenditure. 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 arranged by market capitalization as of end of September, 2021. Schrödinger specialized in developing chemical simulation software for use in pharmaceutical industry holds the first place with \$3.94B of market capitalization.

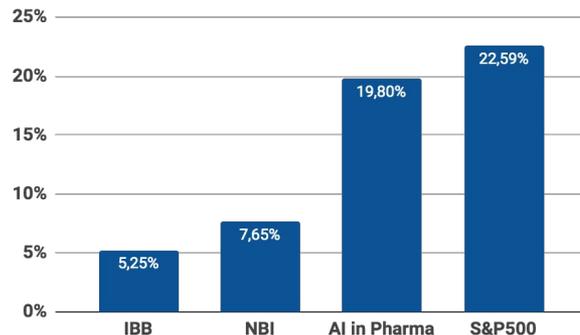
AI in Pharma Market Capitalization

It's essential to measure the performance of publicly traded AI in Pharma companies via comparison with major market benchmarks such as IBB, NBI and S&P 500. The histograms represent the values of the derivatives to the function outlining the approximation of returns via feedforward neural network.

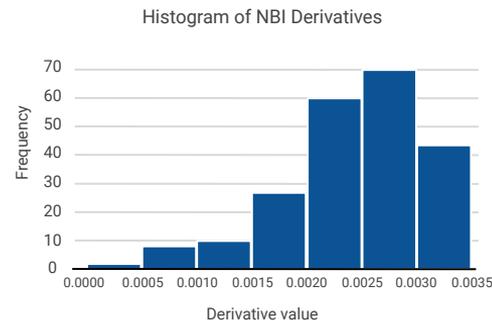
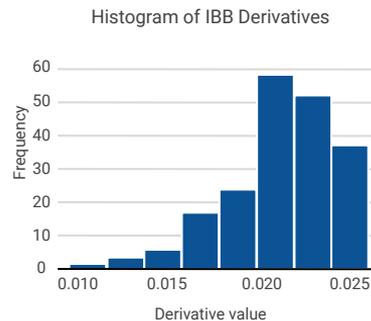
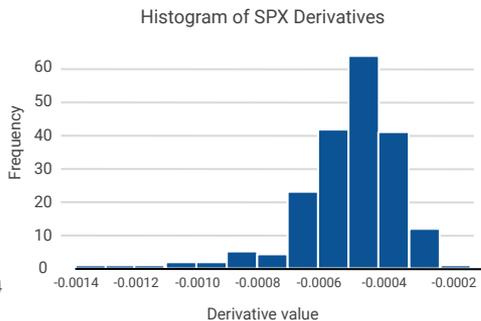
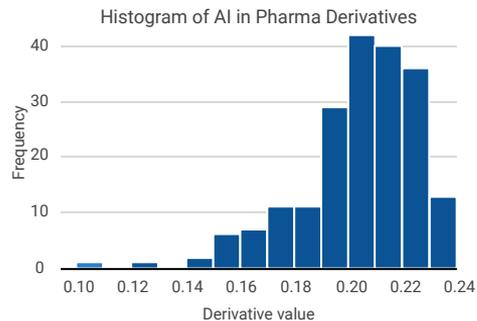
The analysis reveals that SPX returns experience deceleration over time as the values of the function in question are negative. Assessing the returns performance of IBB and NBI shows their lower absolute values compared to AI in Pharma companies returns. This leads to the implication that the companies of the sector have a trend of more dynamic performance over time.

It's also essential to mention that the histogram representing AI in Pharma is right-skewed as the higher returns values prevail. At the same time, all histograms have left tails meaning that both AI in Pharma market and major market benchmarks are exposed to risks to the same extent.

Market Capitalization Growth During Q1-Q3 2021



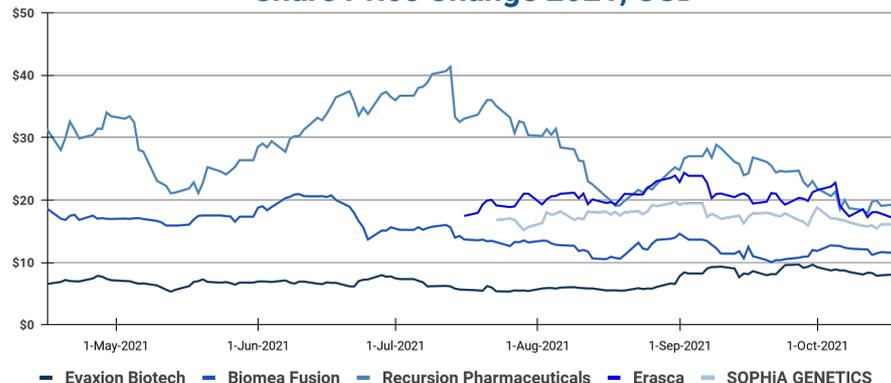
As of the end of Q3 2021 AI in Pharma corporations market capitalization outperforms iShares Biotechnology ETF (IBB) and approaches NASDAQ Biotechnology Index (NBI). However, compared to Q2 2021 S&P 500 has overperformed AI in Pharma sector.



AI in Pharma IPOs in 2021

In 2021 new public companies have successfully closed their IPOs. As for now, almost all these companies are showing a slight decline, which is typical for new pharmaceutical companies, especially with the negative net income. 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 following the general market, yet the degree of such “movements” is lower. Major adverse market events in 2020-2021 did not significantly affect AI in pharma sector. The industry’s features remain to play a designative role in the overall market volatility.

Share Price Change 2021, USD



Name	Country	Funding Amount, \$M	IPO Date	Capitalization, \$M	Valuation at IPO, \$M	IPO Share Price, \$	Current Share Price, \$	EV/EBITDA	Net Income, \$M
Evaxion Biotech	USA	30	04.02.21	159.335	489	10.00	8,28	-6.67	-19.19
Biomea Fusion	USA	153	15.04.21	323.622	463	17.00	11.97	-8.20	-18.88
Recursion Pharmaceuticals	USA	436.4	16.04.21	3263	2748	18.00	23.01	-21.70	-123.75
Erasca	USA	300	16.07.21	2184	1800	16.90	18.02	-16.38	-118,74
SOPHiA GENETICS	USA	250.2	22.07.21	1015	234	18.45	15.90	-18.62	-52

Fundamental Analysis of AI in Pharma Public Companies



- Compared to its peers, EVAXION has the lowest market capitalization and Enterprise Value making Evaxion cash burden is less than its peers.
- Evaxion market capitalization is continuously increasing due to the expectation of advancing clinical trials.
- As of June 2021, Evaxion's cash position of \$18.8 million is expected to be sufficient to fund key clinical programs into 2022.



- Due to the U.S. Food and Drug Administration (FDA) having cleared the company's Investigational New Drug application to begin a Phase I trial of BMF-219, Biome draws attention from investors.
- The company has expanded team and in-house research capabilities to support long-term growth and clinical and preclinical development plans.
- As of June 30, 2021, the Company had cash, cash equivalents, restricted cash, and investments of \$203.0 million.
- The clinical developments of the company should enhance it financial positions.



- Compared to its peers, Recursion Pharma is the one that has a huge revenue growth with 120% in 2021 (LTM). The 74% revenue growth in 2020 makes the company's market position even better.
- One of the reasons that the company wasn't able to reach positive EBITDA is that the company expanded the total number of research and development programs from 37 to 48 as well as its operations to Canada.
- As of June 30, 2021, Recursion's cash and cash equivalents were \$632.7 million.

Fundamental Analysis of AI in Pharma Public Companies



- Berkeley's revenue grew to \$77.8 million for 2021(LTM), representing a 21% growth.
- Berkeley Lights continues to expect full year 2021 revenue to be in the range of \$90 million to \$100 million, representing 40% to 56% growth over the full year of 2020.
- Berkeley kept gross margin above 65% in the last 3 year.
- On the contrary of revenue growth, we saw that Berkeley's market capitalization is decreasing significantly with -57%. The main reason for the decrease in market cap is that the company gave guidance for 2021 in the range of growth between 40% and 56% over the prior year. From investors point of view BLI's growth is about to stumble.



- Relay's revenue goes steady with expectation of 2% growth in 2021.
- Relay has acquired ZebiAI in April 2021 which affected \$134.9 million in expenses.
- Despite the acquisition, the company is projected to reach 50% of the gross margin in 2021, continuing its great performance from 2020, when the margin reached 100%.
- As institutional investors increased their shares in Relay, company's market capitalization increased 3% in 2021 (LTM).
- As of June 30, 2021, cash, cash equivalents and investments totaled approximately \$671.2 million.
- The Company expects its current cash and cash equivalents will be sufficient to fund its current operating plan into 2024.

Fundamental Analysis of AI in Pharma Public Companies



SCHRÖDINGER

- Total Revenue is \$120 million in 2021 (LTM), expected an increase of over 12% compared to 2020.
- Gross profit is expected to reach over \$62 million in 2021 with a gross margin over 62%.
- The company's expenses are projected to scale due the development of its internal drug discovery programs. Operating expenses reached \$42.3 million in Q2-2021, compared to \$30.7 million in Q2-2020.
- Although Schrödinger is expected to maintain its revenue growth rate, it's definitely expected to grow faster than the wider industry.



SOPHiA
GENETICS™

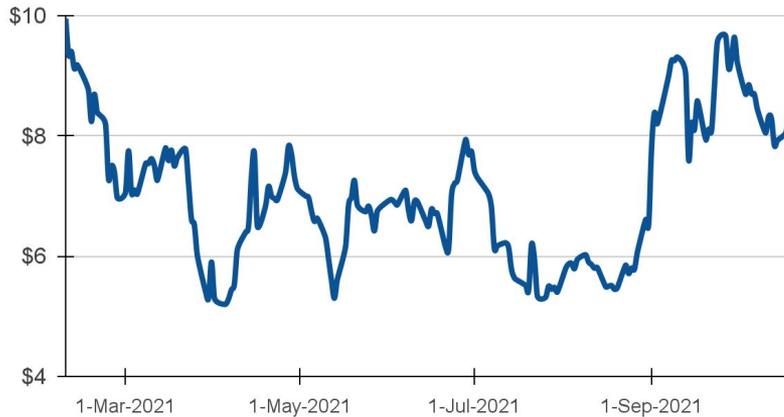
- The company's total revenue for the second quarter of 2021 was \$10.2 million compared to \$5.9 million for the second quarter of 2020, representing a 72% increase. This increase was primarily driven by new customers onboarding onto the platform. Another reason is the usage rates improvement across existing customers.
- SOPHiA Genetics full year revenue for 2021 expects to be greater than \$39 million, representing growth of over 37% compared to the prior year period.
- The decline in gross margin was primarily attributable to increased computational and storage-related costs and negative FX movement. However, the company kept its margin above 60% in the 3 years.



ERASCA™

- The company has successfully closed its \$345 million upsized IPO in July 2021.
- A few reasons that the company has a \$2.3 billion market capitalization:
 1. Nominated ERAS-3490 Development Candidate;
 2. Dosed First Patient in HERKULES-1 Study;
 3. Dosed First Patient in FLAGSHIP-1 Study;
 4. Executive Leadership Team.

Stock Price, USD



EVAX's stock price has been approaching peak growth thanks to newly-created Chief Scientific Officer role strengthens Evaxion's leadership team.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$M
EVAX	-0.11%	5.31%	-16.58%	158.389

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.

The graph below depicts a comparative performance of EVAX and 3 ETFs starting from 08.02.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF (IPO).



Stock Price, USD

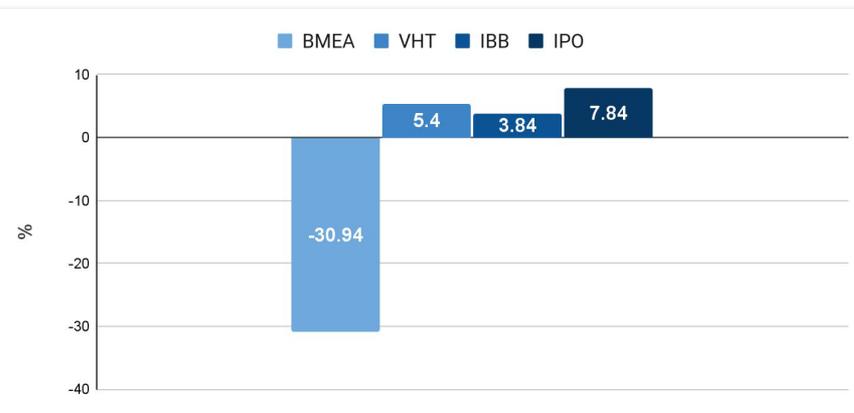


Owing to its IPO, Biomea held unrestricted cash and short-term investments of \$198.6 million and no debt. The company is on pace to burn only \$30 million in 2021.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$M
BMEA	-0.29%	4.52%	-30.94%	336.811

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.

The graph below depicts a comparative performance of BMEA and 3 ETFs starting from 19.04.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF (IPO).



Stock Price, USD



The Institutional investors have recently added to their stakes in the company. Rockefeller Capital Management L.P and Citigroup Inc are among them.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$M
RXRX	-0.26%	5.57%	-28.26%	3.30

Recursion Pharmaceuticals operates as a clinical-stage biotechnology company decoding biology by integrating technological innovations across biology, chemistry, automation, data science, and engineering to industrialize drug discovery.

The graph below depicts a comparative performance of RXRX and 3 ETFs starting from 19.04.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF (IPO).



Stock Price, USD



SOPH is operating in a growing industry, but the proposed IPO terms looked pricey for analysts. Nevertheless, the stock price has risen since then.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$B
SOPH	-0.16%	4.34%	-13.82%	1.015B

SOPHiA GENETICS is a healthcare technology company dedicated to establishing the practice of data-driven medicine as the standard of care and for life sciences research. It is the creator of a cloud-based SaaS platform capable of analyzing data and generating insights from complex multimodal data sets and different diagnostic modalities.

The graph below depicts a comparative performance of SOPH and 3 ETFs starting from 23.07.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF.



Stock Price, USD



Fierce Biotech has named it as one of 2021's "Fierce 15" biotechnology companies, identifying Erasca as one of the industry's most promising biotechnology companies.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$B
ERAS	-0.16%	4.61%	3.38%	2.24B

Erasca develops oncology drugs intended to provide precision oncology options. The company's drugs are being developed through multiple discovery programs for undisclosed targets that are biological drivers of cancer and are pursuing additional opportunities for pipeline expansion through academic and biopharmaceutical collaborations, providing patients with new potential solutions to not just treat but cure cancer.

The graph below depicts a comparative performance of SOPH and 3 ETFs starting from 16.07.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF.



Top AI in Pharma Best-Promising Companies in 2021

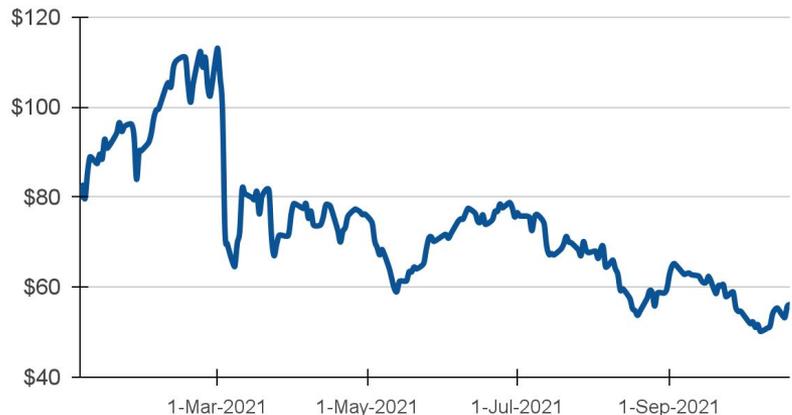
Schrödinger, Berkeley Lights and Relay Therapeutics constitute the group of promising companies selected for analysis. They are new to the market (their IPOs closed in 2020). Therefore, their future might change significantly. Moreover, they have decent multi-target pipelines of novel therapeutics to 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.

Share Price Change 2021, USD



Name	Country	Funding Amount, \$M	IPO Date	Capitalization, \$M	Valuation at IPO, \$M	IPO Share Price, \$	Current Share Price, \$	EV/EBITDA	Net Income, \$M
Schrödinger	USA	562.3	02.05.2020	3905	819	17.00	54.68	-67.90	-41.960
Berkeley Lights	USA	208.5	17.07.2020	1684	1355.2	19.00	19.56	-23.26	-54.318
Relay Therapeutics	USA	520.0	16.07.2020	3166	1736	20.00	31.53	-20.88	-236.384

Stock Price, USD



According to the analyst, compared to the current share price, the company appears a touch undervalued at a over 20% discount to where the stock price trades currently.

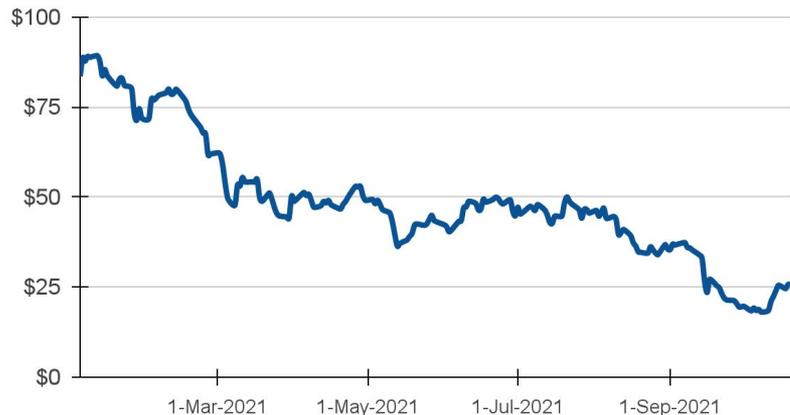
Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$B
SDGR	-0.17%	4.13%	75.85%	3.94

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.

The graph below depicts a comparative performance of SDGR and 3 ETFs: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF (IPO).



Stock Price, USD



Shares of Berkeley Lights have been surging consistently after revenue results in Q3-2021. The company reported its largest revenue placement estimated between the range of \$24m to 24.3m – a 33% growth year-over-year.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$B
BLI	-0.59%	4.30%	-58.78%	1.71

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 graph below depicts a comparative performance of RXXR and 3 ETFs starting from 04.01.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF (IPO).



Stock Price, USD

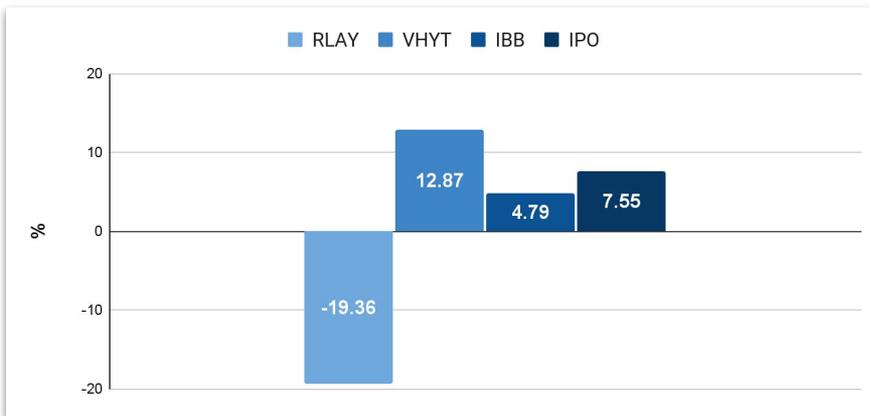


93.9% of RLYA shares are owned by institutional investors which indicates endowments, large money managers and hedge funds believe a stock will outperform the market.

Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, \$B
RLYA	-0.13%	3.25%	-29.01%	3.30

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.

The graph below depicts a comparative performance of RLYA and 3 ETFs starting from 04.01.2021: Vanguard Health Care Index Fund ETF (VHT), iShares Nasdaq Biotechnology ETF (IBB), Renaissance IPO ETF (IPO).



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/EBITD A	Net Income, \$M
Gritstone Oncology	509.08	1.35%	19.11%	0.09	27.40	396	-157.42%	-5.39	-70.46
Lantern Pharma	114.58	-0.18%	4.49%	N/A	0.33	68.73	0.00%	-4.23	-9.36
Alector	1907	0.43%	6.66%	1.16	0.25	194.50	-999.44%	-7.99	-212.20
Relay Therapeutics	3138	-0.06%	3.93%	N/A	1.57	520.00	-121.67%	-20.88	-236.38
Schrödinger	3863	-0.11%	4.04%	N/A	0.04	562.32	-0.52%	-107.91	-41.960
Sensyne Health	180	0.25%	6.79%	0.36	0.06	36.76	-294.50%	-7.18	-27.52
Berkeley Lights	1694	-0.69%	4.16%	0.50	0.17	272.57	-68.11%	-23.26	-54.32

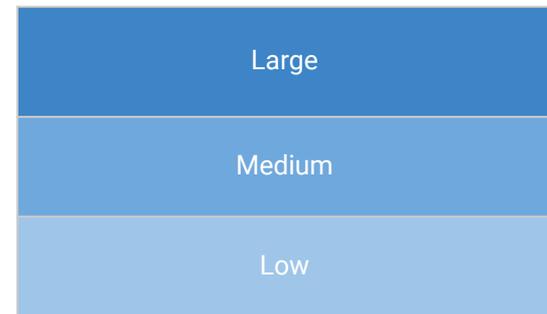
AI in Pharma corporations tend to be more volatile than average publicly traded company.. For most of the corporations, daily returns are positive and abnormal compared to the market. More volatile stocks are usually characterized by higher betas (both calculated for IBB index and for S&P 500). AI in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

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
Biosesix	203.763	-0.31%	5.59%	0.03	-0.27	239.66	-29.39%	-7.41	-31.74
C4X discovery	64.243	0.03%	2.69%	0.32	0.37	6.71	0.00%	-5.88	-7.44
Cotinga Pharmaceuticals	10.993	0.69%	5.31%	1.45	-0.05	6.64	0.00%	-0.17	-2.538
DeepMatter Group	11.761	-0.08%	4.27%	1.06	0.05	0.00	-216.97%	-4.62	-2.621
eTherapeutics	159.51	0.47%	4.06%	-0.16	0.77	98.54	-1288.64%	-33.50	-3.684
GenFit	173.39	-0.12%	2.57%	1.16	0.22	93.69	-1048.54%	-4.61	-39.152
Biomea Fusion	344.50	-0.27%	4.73%	N/A	-0.06	56.00	0.00%	-8.20	-18.884

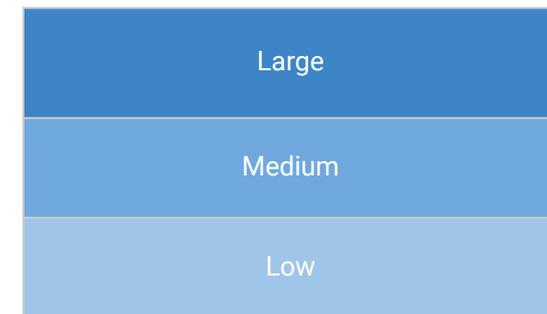
Market capitalization of some AI in Pharma corporations (such as Schrödinger) exceeds **\$6B** whereas other companies are priced in the range of dozens of millions of dollars - the difference in the valuation is immense. There is no strong correlation between operating margin or net income and market 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.



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	797.56	-0.13%	4.14%	1.05	0.01	777	0.00%	-5.95	-99.83
Evolutionary Genomics	5	0.32%	8.82%	0.17	-0.02	7.35	0.00%	-4.86	-2.24
IDEAYA Biosciences	900.93	0.43%	4.18%	1.76	0.02	226.10	-85.71	-25.03	-30.02
ITeos Therapeutics	958.41	0.01%	4.94%	0.00	-0.01	249.74	0.00	-9.87	-65.58
Recursion Pharmaceuticals	3213	-0.11%	5.44%	0.00	0.02	465.38	-1346.17%	-21.70	-123.76
Sangamo Therapeutics	1266	-0.79%	7.89%	1.67	0.01	92.20	-103.21%	-6.18	-135.26
Renalytix AI	882.42	-0.31%	8.77%	1.24	-0.05	46.12	-2612.86%	-27.47	-27.29
Evaxion Biotech	152.60	0.13%	5.45%	0.00	0.01	17.00	0.00	-6.67	-19.19

Market capitalization growth of AI-driven Pharma corporations exceeds that of the entire market and general BioTech Industry indices represented as 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

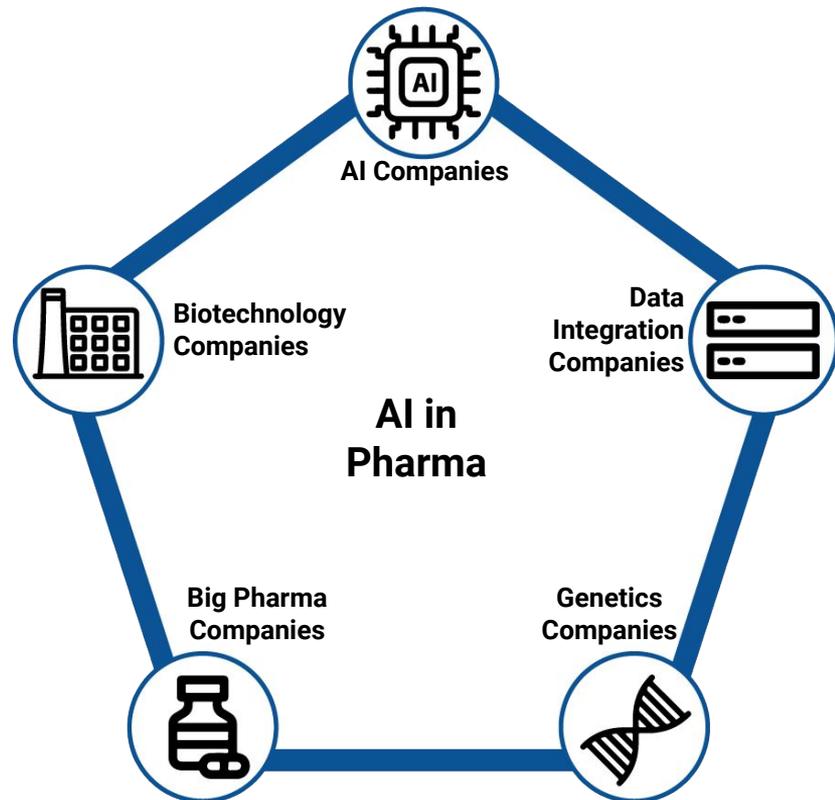


Companies Related to AI-Pharma

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.

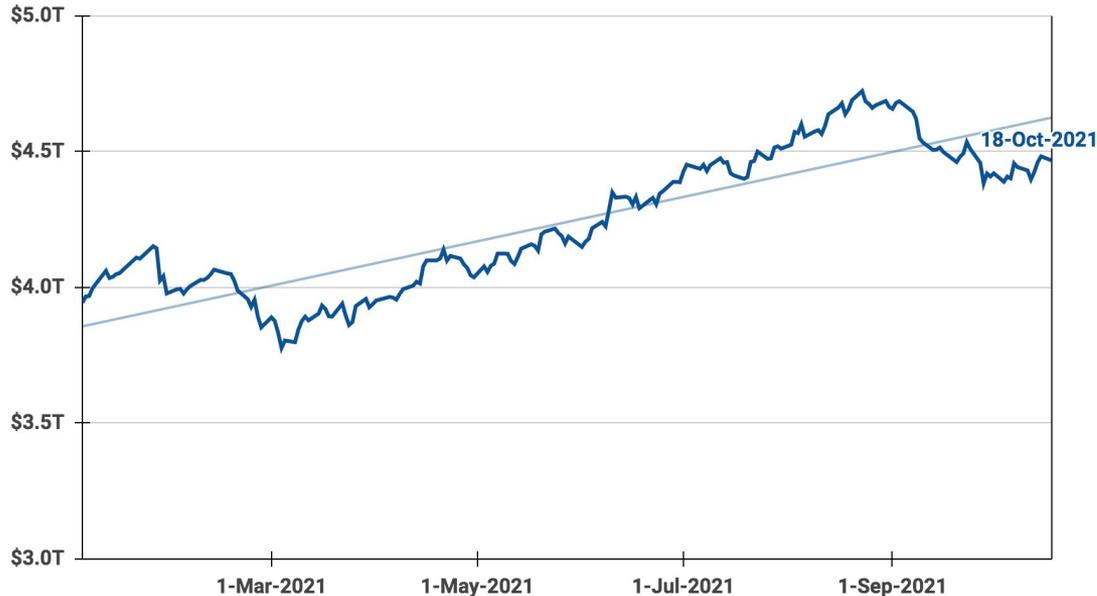
The number of new partnerships between pharma companies and AI companies is ever increasing across the whole industry. On the one hand, AI-focused companies may spend a few years developing all software and tools which pharma companies do not have. On the other hand, large companies, mainly public ones, 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

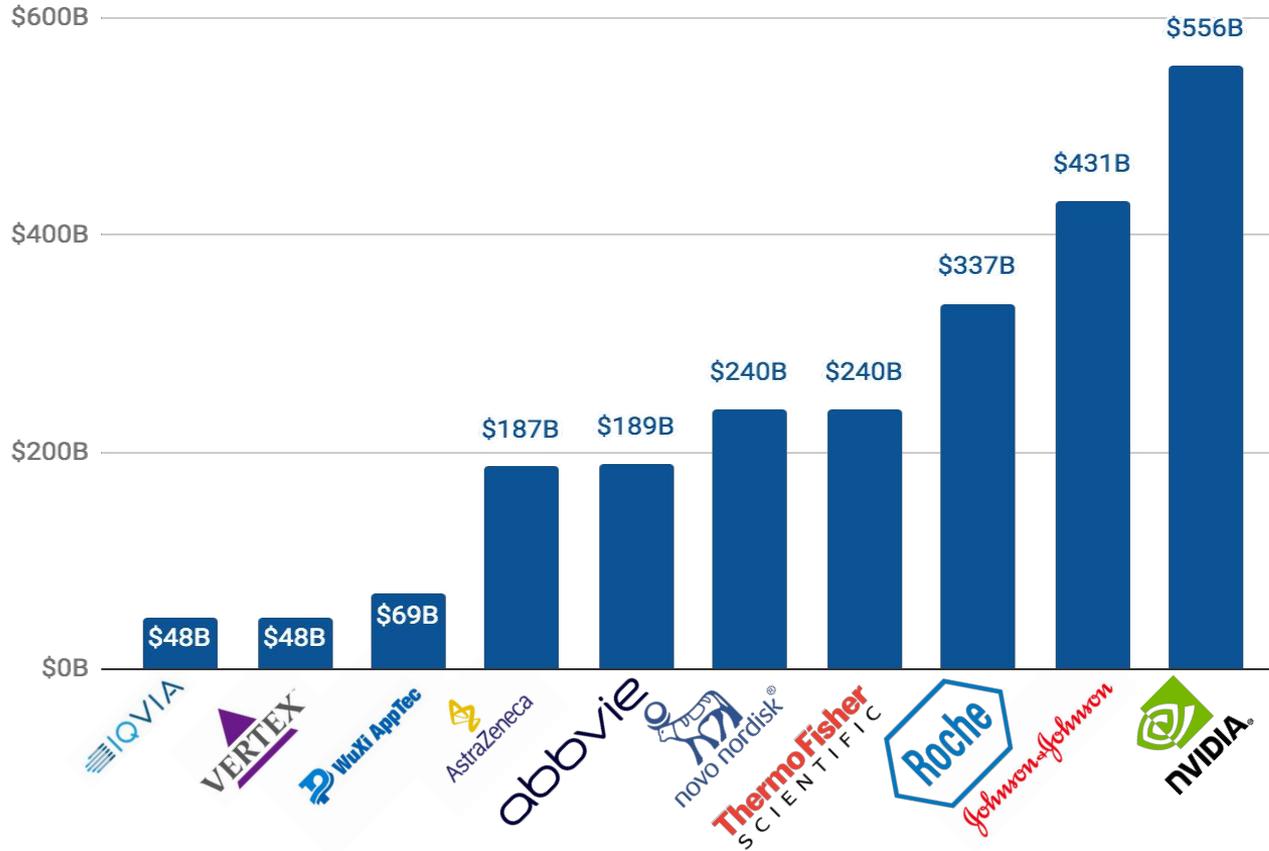
Cumulative Capitalization of Publicly Traded Companies Related to AI-Pharma, 2020-2021, \$ Trillion



Driven to some degree by the COVID-19 pandemic, publicly traded companies related to AI-Pharma demonstrated significant growth, **reaching \$4.47T** industry capitalization in October 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 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 the top 10 public companies that ended up in our portfolios according to their market capitalization. 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 at our top. During the last year and a half period of pandemic, AstraZeneca has being raised the capitalization by more than 11 times, reached \$186.7B.

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: Abbfish 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 to 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.

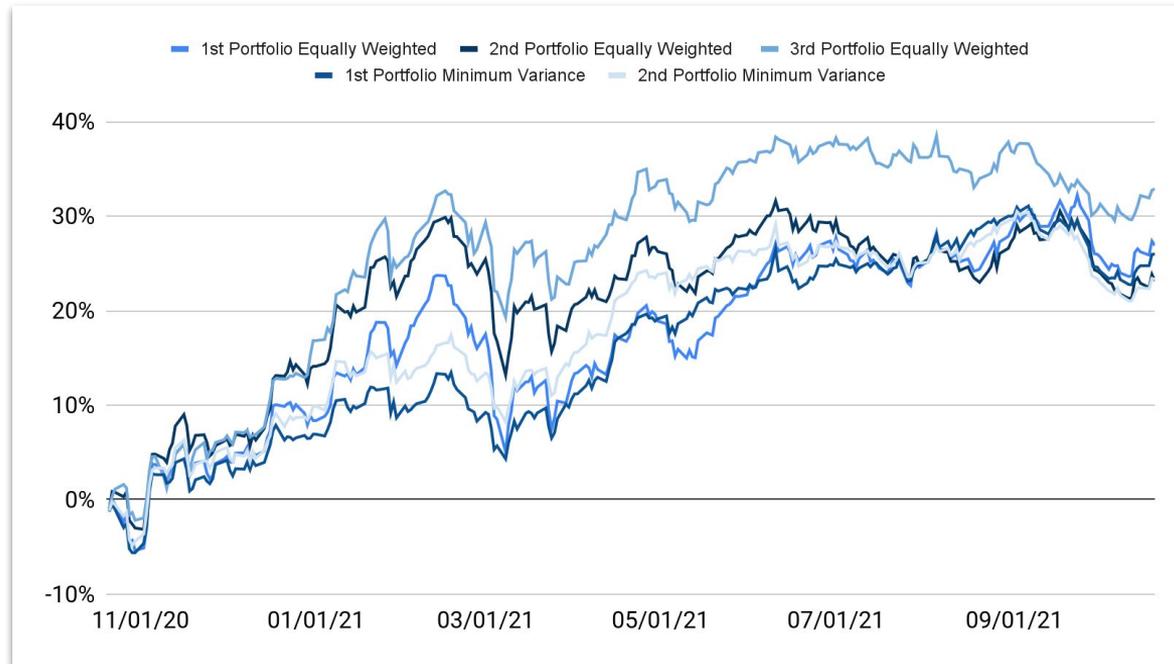


Almirall (ALM) – Almirall is a leading skin-health focused global pharmaceutical company, that has some recent collaborations with Iktos for the creation of generative modelling AI technology for quick identification of molecules with multiple bioactivity and drug-like criteria.



Overall Performance / Equally Weighted and Minimum Variance Portfolios

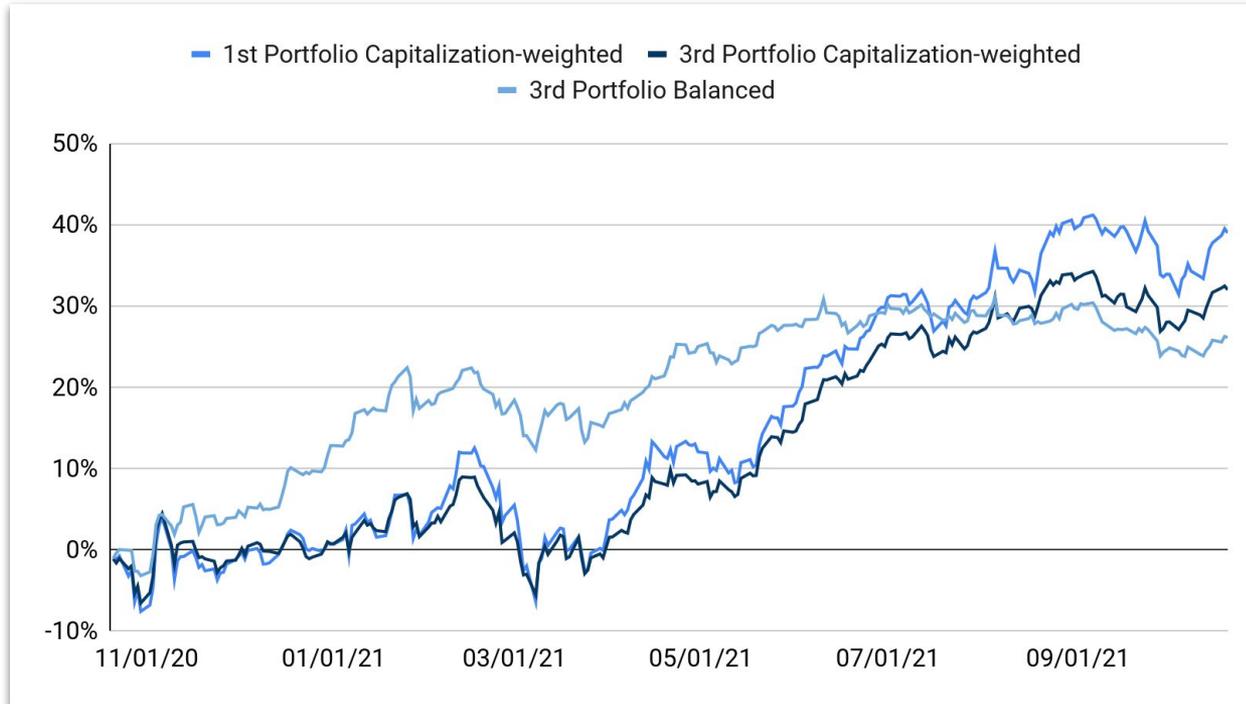
DPI analytics used five different strategies during the creation of portfolios: Equally Weighted, Minimum Variance, Capitalization-weighted, Balanced and Sharpe Ratio-based strategies.



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.

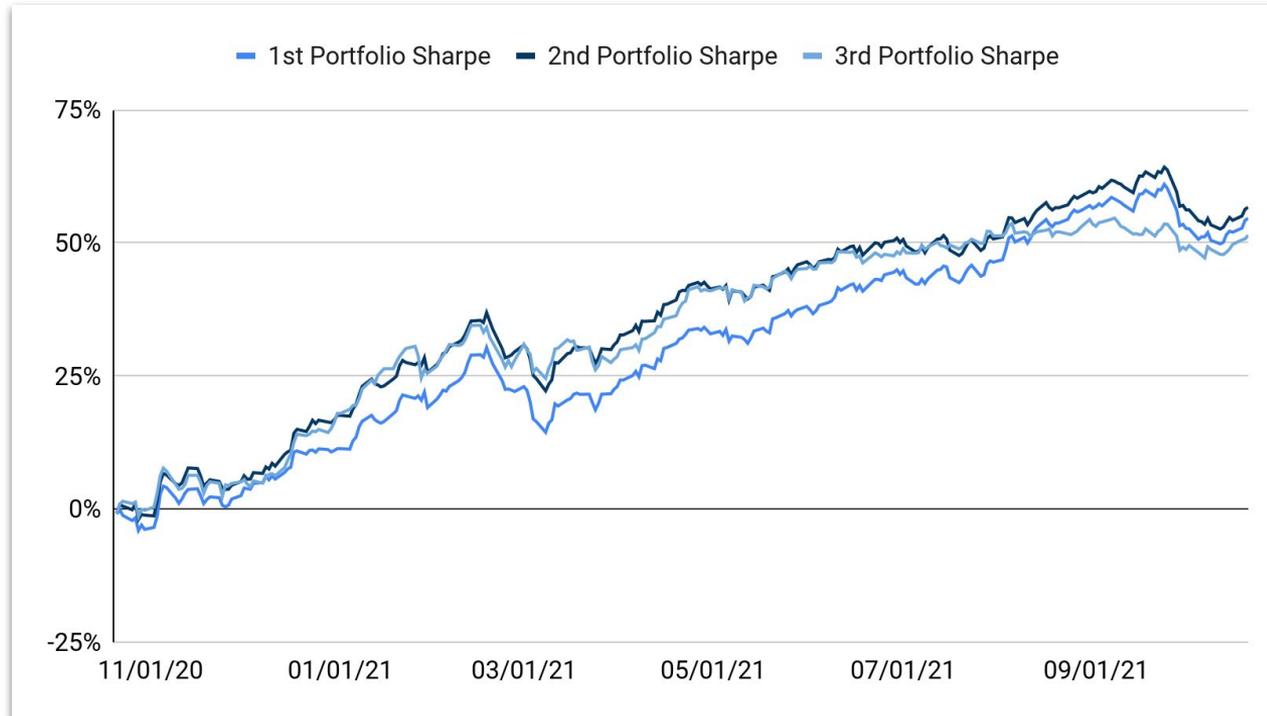
Overall Performance / Capitalization-weighted and Balanced Portfolios

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:



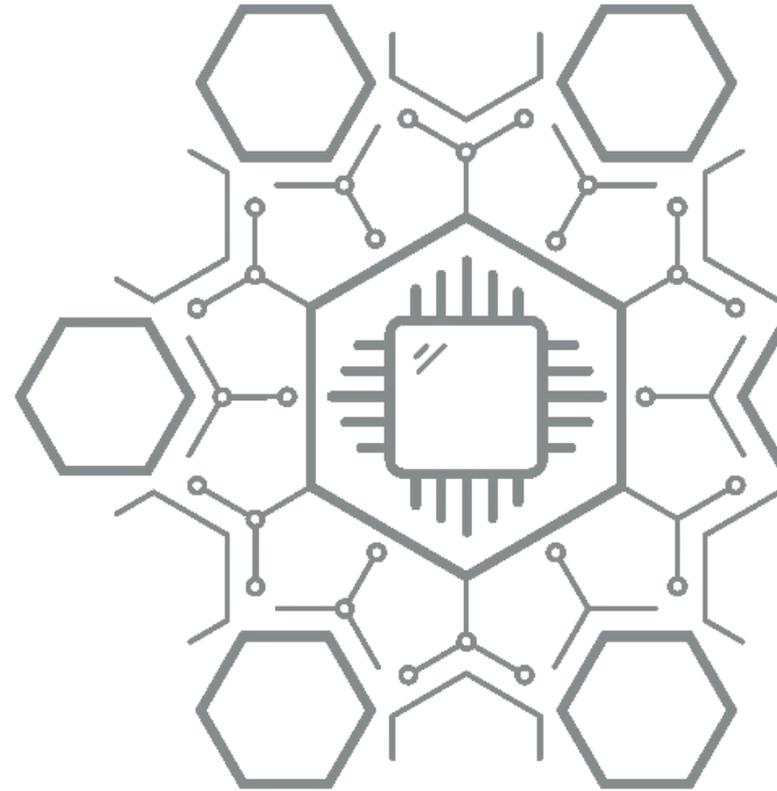
Overall Performance / Performance matrix

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
1st Portfolio	26.90% 1.16%	38.97% 1.47%	25.99% 0.87%	54.62% 1.12%	24.46% 0.92%
2nd Portfolio	23.17% 1.13%	24.97% 1.08%	23.31% 0.86%	56.68% 1.14%	21.25% 0.90%
3rd Portfolio	32.88% 1.13%	31.96% 1.18%	22.80% 0.85%	51.43% 1.11%	26.08% 0.92%

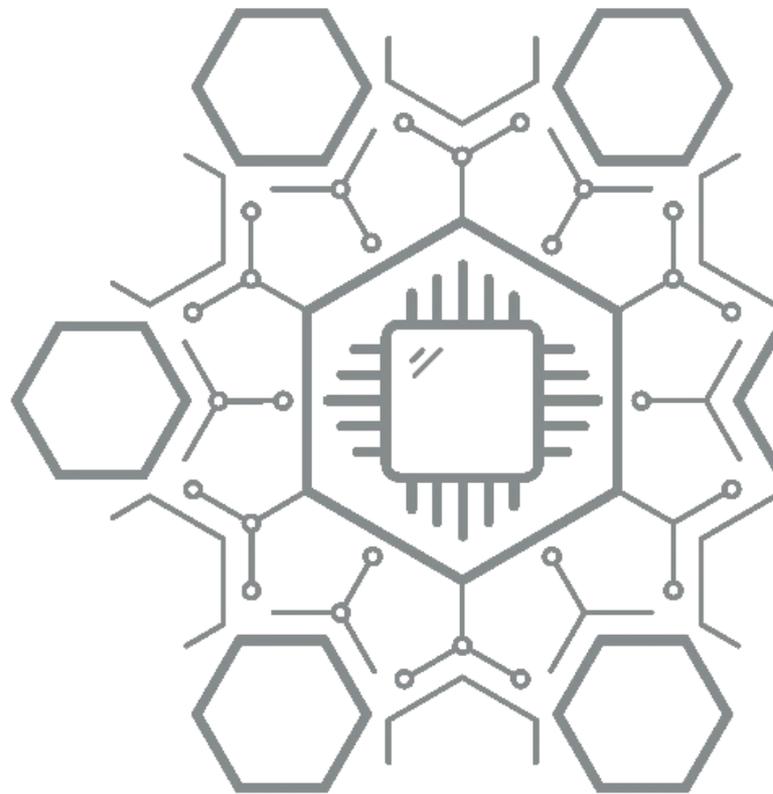
Conclusions

- 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.
- 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.
- 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**.



Conclusions

- There are plenty of companies that should be considered as promising ones, which shows both market dynamics and investment expediency.
- Best performance is shown by Sharpe ratio-based portfolios, our Balanced portfolios have outperformed all classical Capitalization-based portfolios showing higher investment expediency.
- 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
INTELLIGENCE

Deep Pharma Publicly Traded Companies Big Data Analytics Dashboard

Landscape Analytics

AI in Pharma 2020 Industry Landscape

Mindmap (Sectors)
Mindmap (Sub-Sectors)
Mindmap (Regions)

AI in Pharma Industry Landscape



View More

Dashboard Parameters

COMPANIES	PARAMETRS	MONTHS PERIOD
29	45	12
PORTFOLIO TYPES	PORTFOLIO SETS	DATA POINTS
5	11	9882

Investment Digest 2021

INVESTMENT DIGEST
AI in Pharma Publicly Traded Companies 2021

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Investment Digest
Funding Rounds
Deals

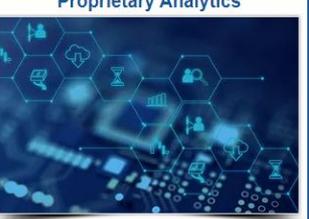
Industry Developments

Companies Database



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AI in Drug Discovery
Business Trends
Investment Trends
Technology Trends
Current Challenges

Deep Pharma Publicly Traded Companies Big Data Analytics Dashboard

AI for Advanced R&D: Applications and Use Cases



DEEP
PHARMA
INTELLIGENCE

Notable AI Breakthroughs

Mar 2018

IBM Watson released a cognitive computing platform for **Clinical trial matching** that has shown significant improvement in patient enrollment rate at **Mayo Clinic**. The platform demonstrated an **80% increase** in enrollment in clinical trials for breast cancer and a decrease in time to match a clinical trial to one patient.

Oct 2018

Healx has prepared a rare disease **Fragile X syndrome drug** for a **Phase 2a clinical trial** in 15 months. Healx has demonstrated the power of combining domain expertise, deep learning, and proprietary data.

Dec 2018

DeepMind built the **AlphaFold platform** to **predict 3D protein structures** that outperformed all other algorithms. AlphaFold won the **CASP13 competition**, where it could most accurately predict the shape for 25 of the 43 proteins without using previously solved proteins as templates.

Jan 2019

Recursion Pharmaceuticals has evaluated Takeda's preclinical and clinical molecules in over 60 indications in less than 18 months by Recursion's AI-enabled drug discovery platform.

Sep 2019

Insilico Medicine has published a research paper about the first in vivo active drug candidate developed from scratch (de-novo) in **46 days** (with target selection) using the **GENTRL AI-based system**.

Notable AI Breakthroughs

Sep 2019

Deep Genomics created a DG12P1 drug in 18 months using an **AI-augmented drug design**. It is an **antisense oligonucleotide therapy** to treat **rare Wilson disease**. Deed Genomics platform screened over 2,400 diseases and over 100,000 mutations to predict and confirm the precise disease-causing mechanism of the mutation Met645Arg.

Jan 2020

Mendel Recruit proprietary platform **increases patient enrollment for clinical trials by 24-50%**. It applies AI algorithms that combine the recognition of scanned documents with **natural language processing** of clinical records and automated clinical reasoning.

Jan 2020

A new drug candidate, DSP-1181, created using the **Exscientia Centaur Chemist Artificial Intelligence platform**, began clinical study. The drug was developed together with **Sumitomo Dainippon Pharma** for the treatment of an **obsessive-compulsive disorder**. It was advanced to Phase 1 clinical trials.

Feb 2020

Scientists from **MIT** discovered **halicin** – **a new super powerful antibiotic capable of killing 35 of the world's most problematic disease-causing bacteria**, including multiresistant strains. The model applied was able to screen more than a hundred million chemical compounds and pick out potential antibiotics that kill bacteria using different mechanisms than existing drugs.

Sep 2020

Aladdin has built a platform for the **early diagnostics of Alzheimer's disease and COVID-19**. Disease Diagnosis platform uses **AI** and **multimodal data**, including biomarkers, imaging, blood samples, medical records, etc.

Notable AI Breakthroughs

Sep 2020

MELLODDY – the '**Machine Learning Ledger Orchestration for Drug Discovery**' group – was created by ten pharma companies to **develop ML models** without sharing data. MELLODDY leverages the world's most extensive collection of small molecules with known biochemical or cellular activity to provide more accurate predictive models and **improve drug discovery efficiency**.

Feb 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**. The company is preparing for clinical development.

Mar 2021

Cyclica launched an AI-based drug discovery platform that **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. These partnerships have resulted in 64% of programmes resulting in actionable hits.

May 2021

BioXcel Therapeutics, Inc., a clinical-stage biopharmaceutical company **utilizing AI approaches**, announced that the FDA has accepted for filing the New Drug Application for BXCL501, for the **acute treatment of agitation associated with schizophrenia and bipolar disorders I and II**.

May 2021

Using its AI technology, **Exscientia** designed an **Alzheimer's disease drug candidate** who 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

Notable AI Breakthroughs

Jul 2021

The **University of Washington** has developed a **deep learning model**, “**RoseTTAFold**”, that **calculates protein structure on a single gaming computer within ten minutes**.

Aug 2021

Insilico Medicine announces the **preclinical candidate for kidney fibrosis** discovered using **end-to-end Artificial Intelligence engine**. The preclinical candidate has the desirable pharmacological properties, pharmacokinetic profile and demonstrated auspicious results in in-vitro and in-vivo preclinical studies.

Oct 2021

Exscientia, in cooperation with the **Medical University of Vienna**, published a paper that illustrates the potential real-world impact of using Exscientia’s AI-supported precision medicine platform. The platform proposes the **most effective therapy for late-stage haematological cancer patients** based on testing drug responses ex vivo in their own tissue samples.

Oct 2021

AstraZeneca, Merck, Pfizer and **Teva** formed **AION Labs**, the innovative lab that will **create and adopt AI technology to transform the process of drug discovery**. AION Labs will create and invest in companies that implement AI for drug development. Additionally, they will offer special resources and mentorships to such companies.

Oct 2021

The **AI-empowered company Healx** has secured FDA approval for a **phase 2a clinical trial** of an AI-discovered compound that could help manage the symptoms of the **genetic disorder Fragile X syndrome**.

Computational Methods Used by the Most Advanced AI Companies



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.

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



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 skepticism. 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, bacteria, mammalian cells) which are capable to produce complexly structured products as proteins, hormones, RNA and DNA products, viruses capsids. Whereas 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 minimize 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:



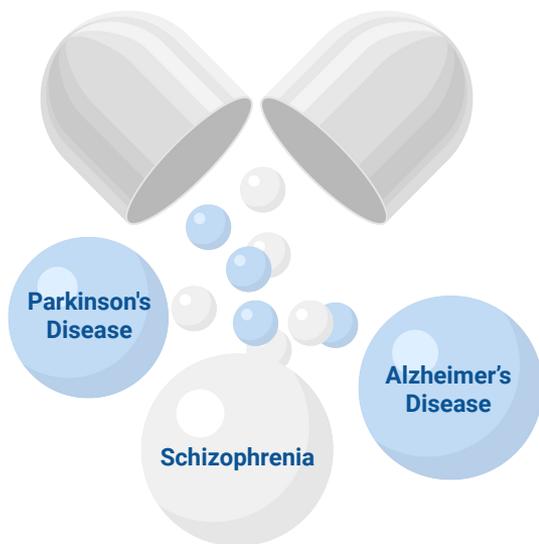
Most Innovative R&D Approaches of AI in Biopharma. Abbvie



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:

- Mission Therapeutics
- AiCure



mission
therapeutics



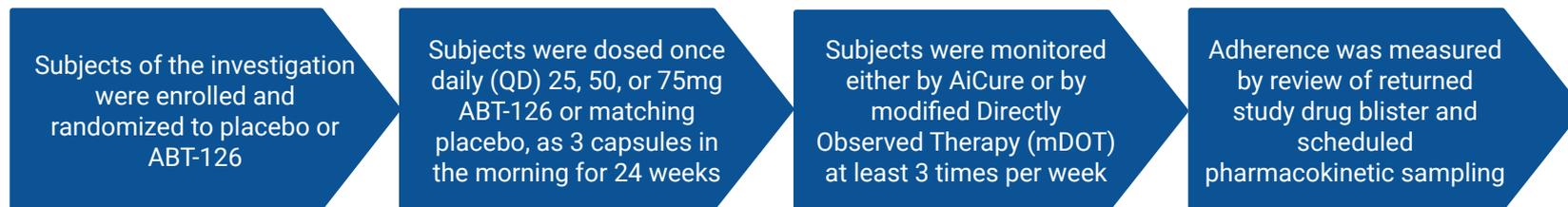
AiCure

How Abbvie Uses AI in R&D?

abbvie

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.

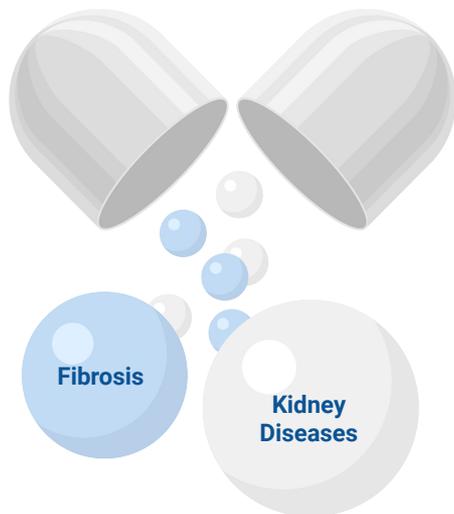
Most Innovative R&D Approaches of AI in Biopharma. AstraZeneca



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:

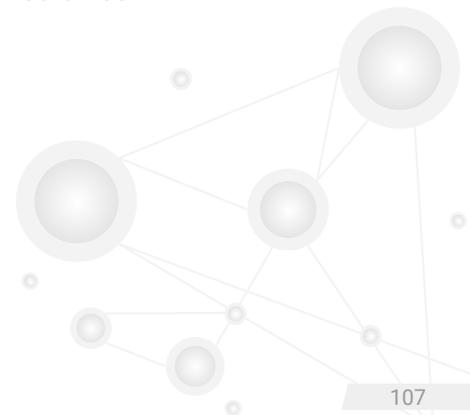


The way AI is used:

- 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
- 



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 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.

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

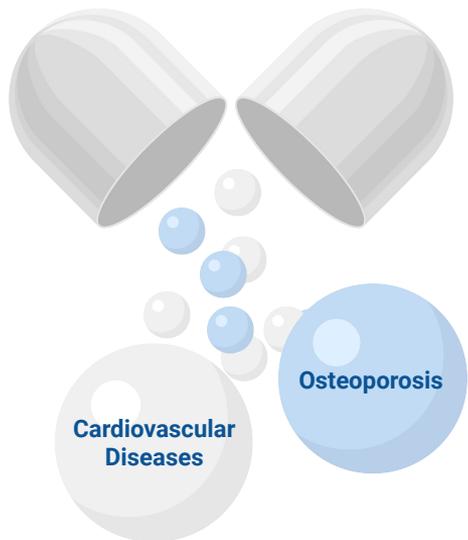


Amgen is one of the world's leading biotechnology companies committed to unlocking the potential of biology for patients suffering from serious illnesses by discovering, developing and manufacturing innovative human therapeutics.

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:

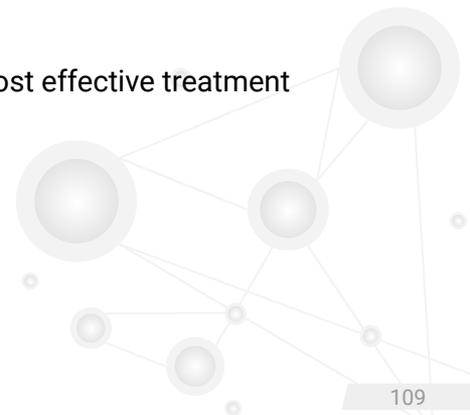


The way AI is used:

- 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

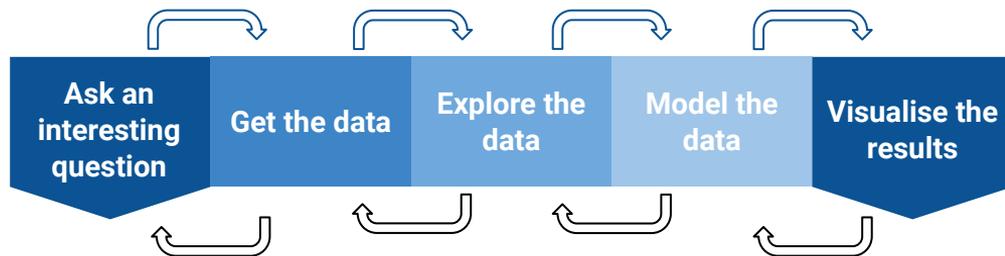


How Amgen Uses AI in R&D?



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 a 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.

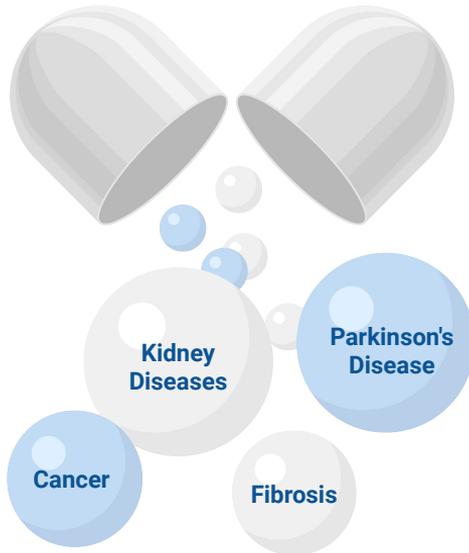
Most Innovative R&D Approaches of AI in Biopharma. BenevolentAI

BAI

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 identify specific drug target
- in molecular design
- in patient stratification

Cooperation:

- Neuropore Therapies
- Novartis

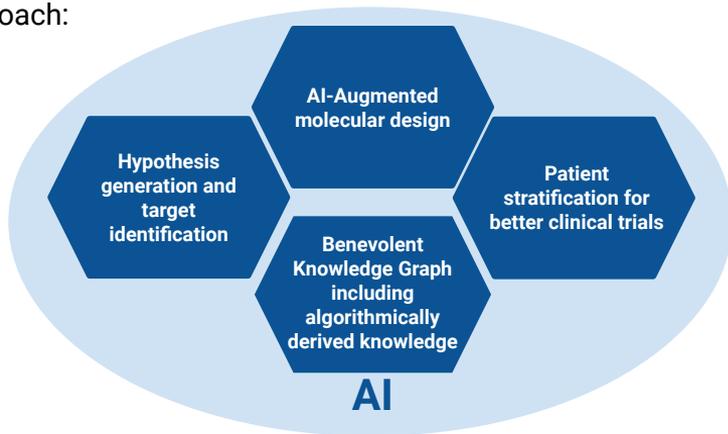


How BenevolentAI Uses AI in R&D?

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.

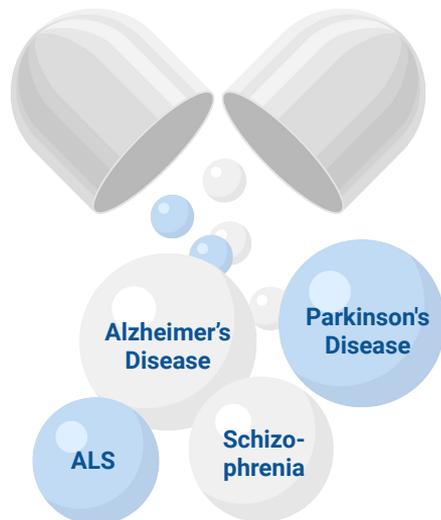
Most Innovative R&D Approaches of AI in Biopharma. BenevolentAI



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:

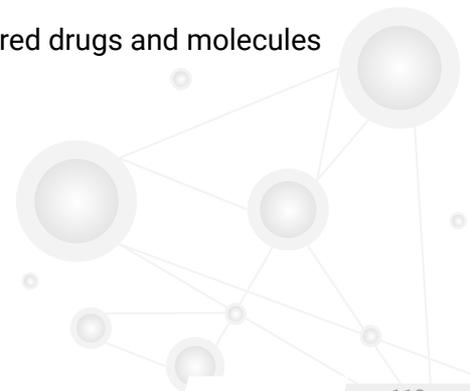


The way AI is used:

- 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



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, SoundTalks analytical audio algorithms can lead to the earlier diagnosis of diseases in humans and animals.

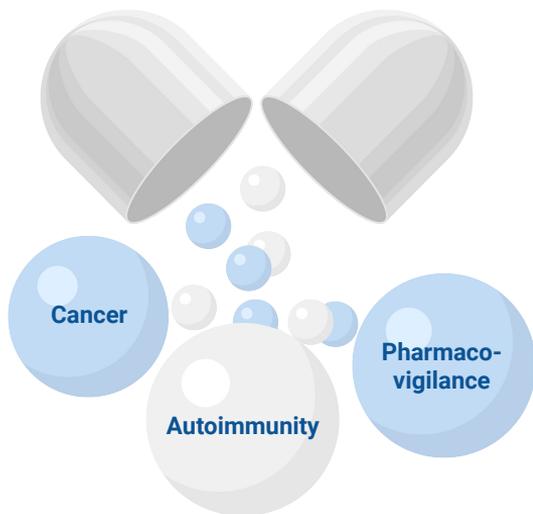
Most Innovative R&D Approaches of AI in Biopharma. Celgene



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

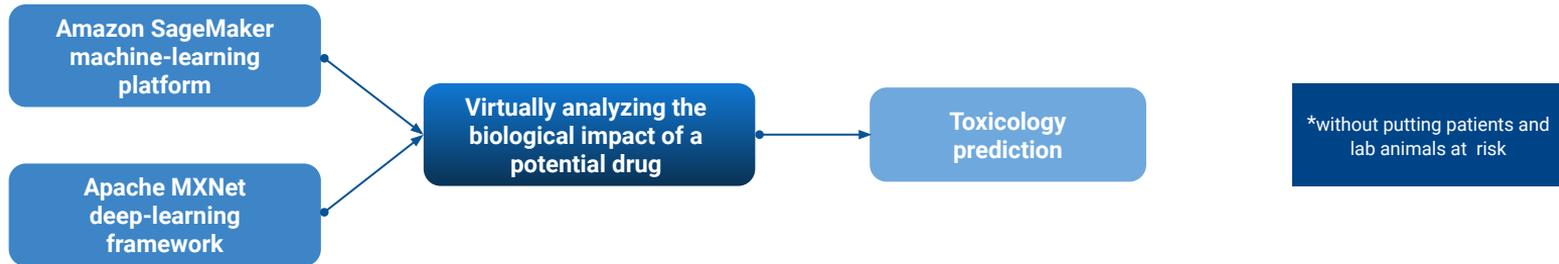


How Celgene Uses AI in R&D?



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.

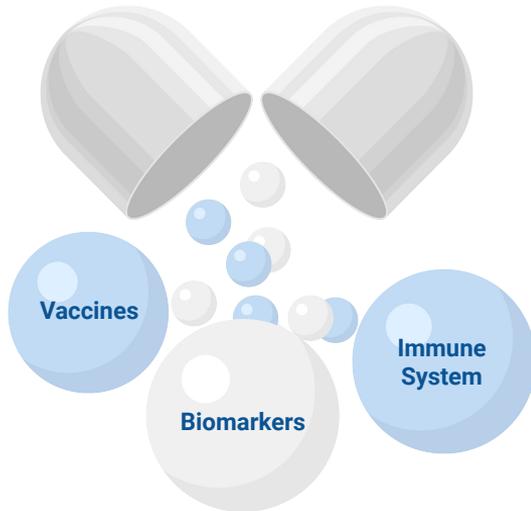
Most Innovative R&D Approaches of AI in Biopharma. GSK



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 optimise interpretation of genetics and genomic data
- to understand the effect of interventions on diseases

Cooperation:

- Exscientia
- Insilico Medicine

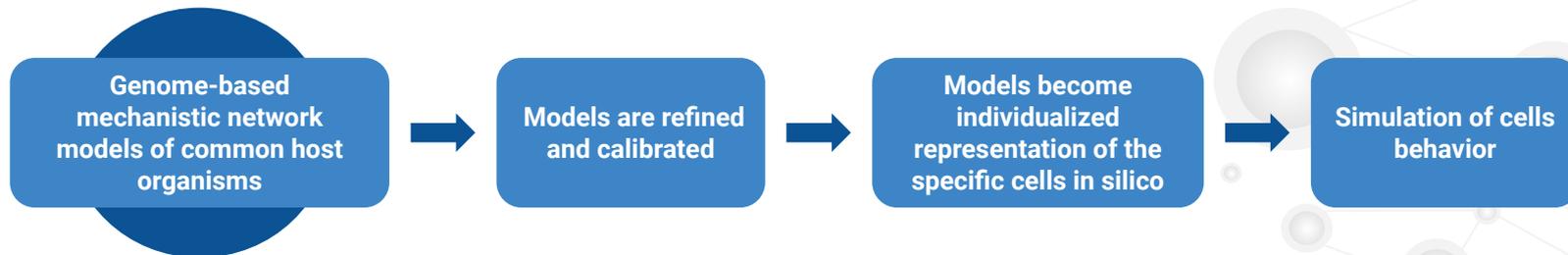


How GSK Uses AI in R&D?



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:



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:



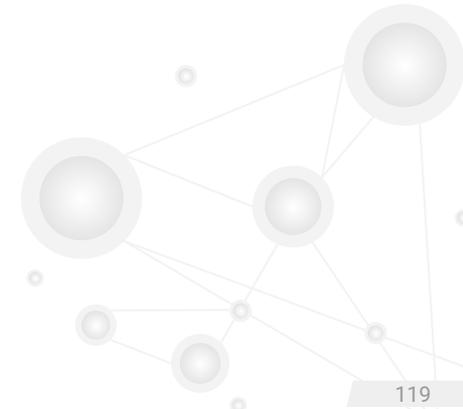
The way AI is used:

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

Cooperation:

- insitro

insitro



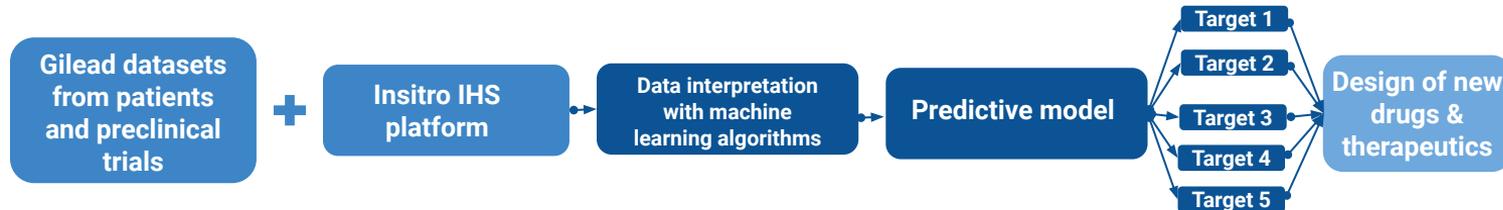
How Gilead Uses AI in R&D?



GILEAD

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.

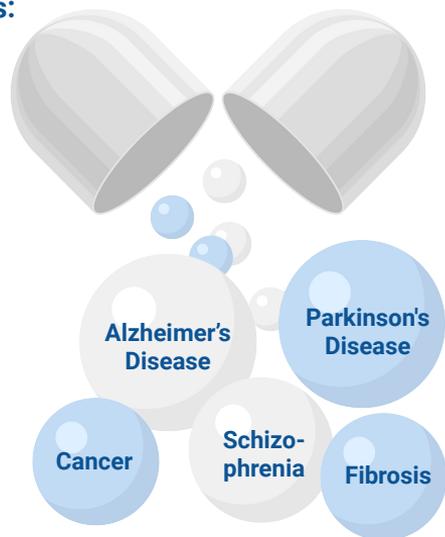
Most Innovative R&D Approaches of AI in Biopharma. Insilico Medicine



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

 BIOTIME

JUVENESCENCE.AI

Bitfury

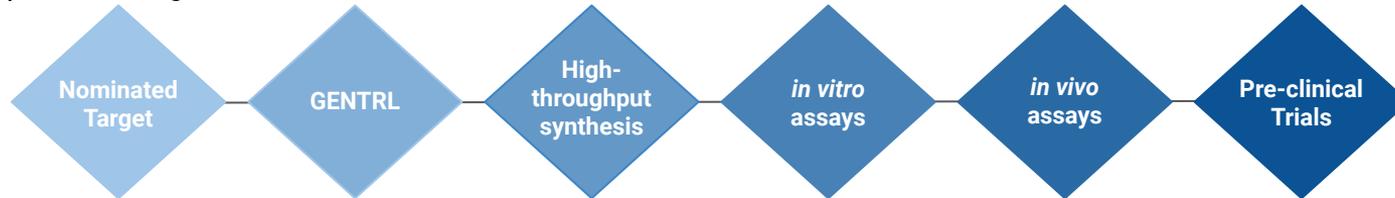


How Insilico Medicine Uses AI in R&D?



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.

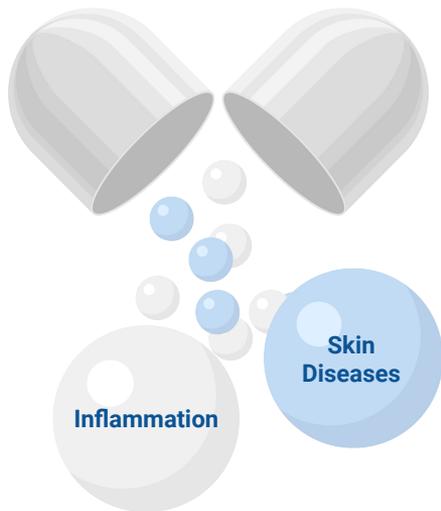
Most Innovative R&D Approaches of AI in Biopharma. Nuritas

NURITAS

Nuritas is revolutionising the discovery of novel, natural and active ingredients that were tested 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:

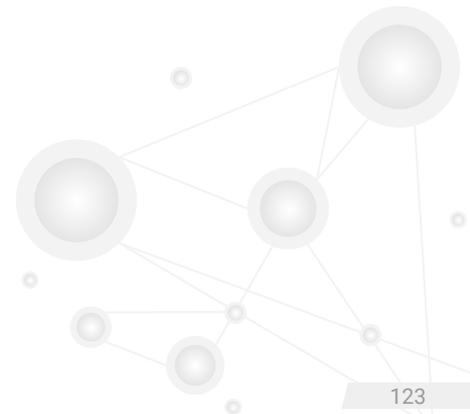


The way AI is used:

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

Cooperation:

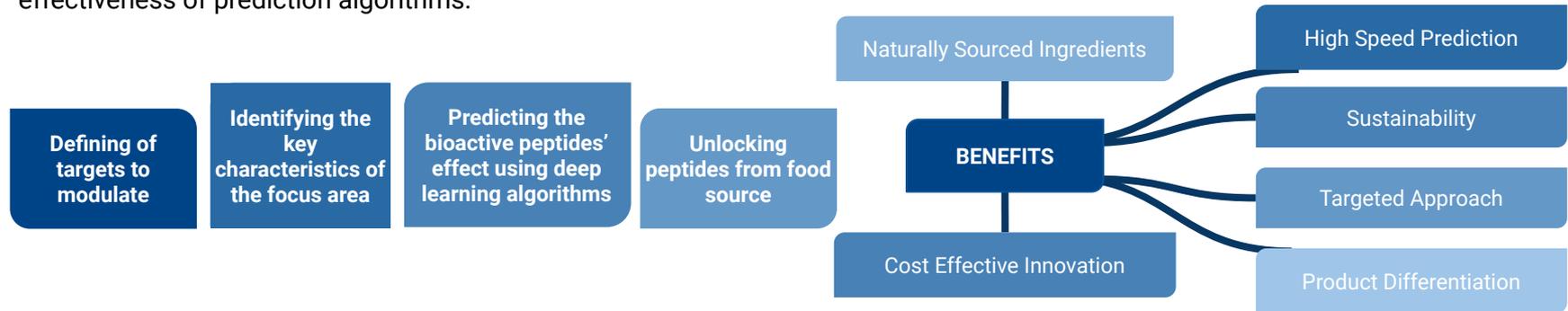
- BASF



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.

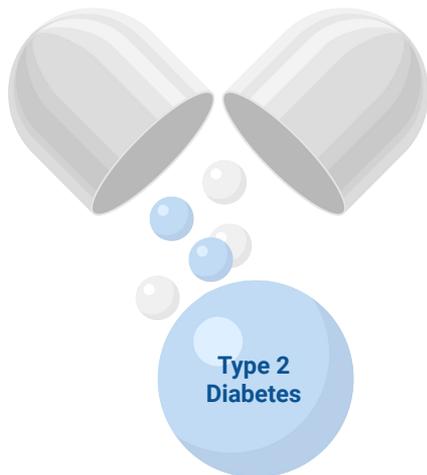
Most Innovative R&D Approaches of AI in Biopharma. Novo Nordisk



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
-  e-therapeutics

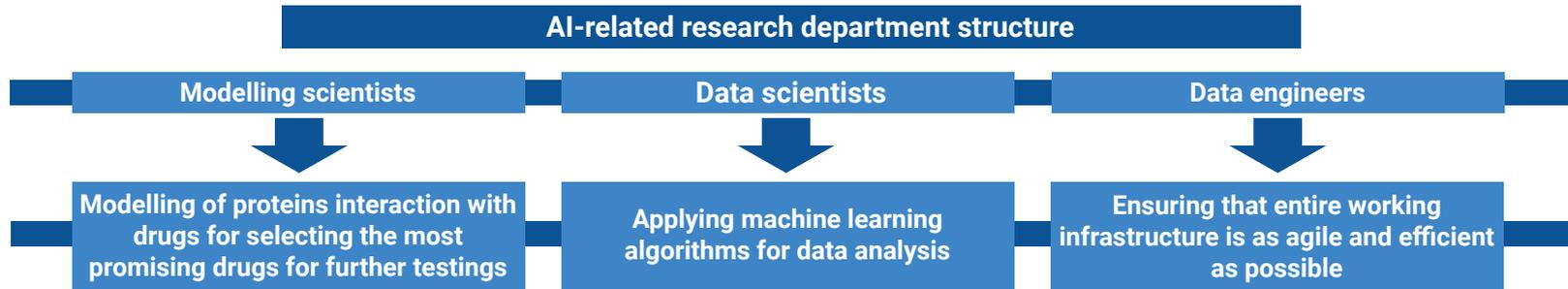


How Novo Nordisk Uses AI in R&D?



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.

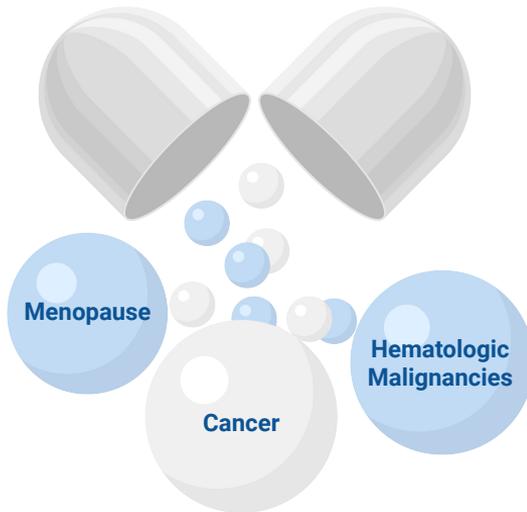
Most Innovative R&D Approaches of AI in Biopharma. Pfizer



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:

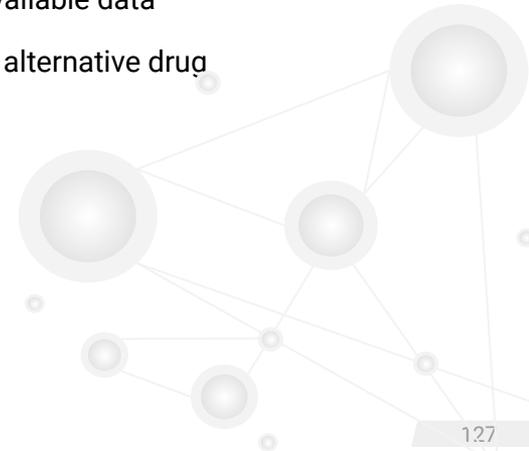


The way AI is used:

- 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

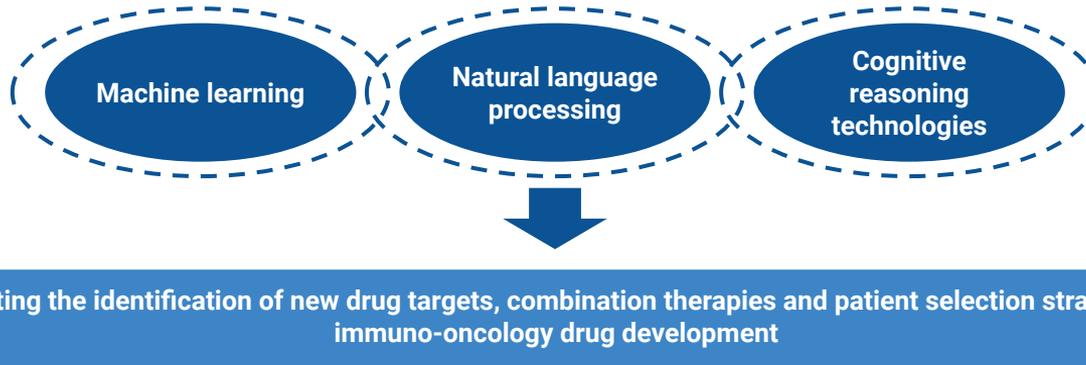


How Pfizer Uses AI in R&D?



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:



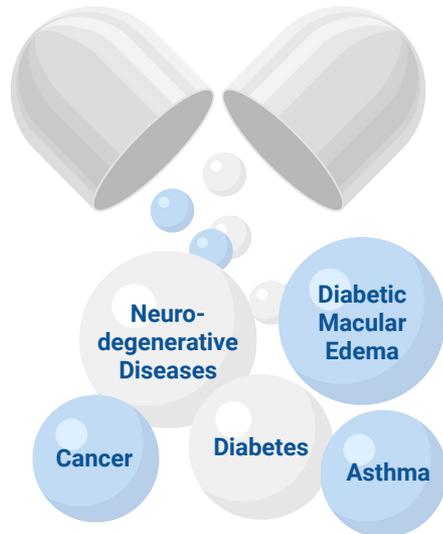
2. Pfizer uses newly launched Watson for Drug Discovery, a cloud-based system that aims to help life sciences researchers discover new drug targets and alternative drug indications. The average researcher reads between 200 and 300 per year, while Watson for Drug Discovery has ingested 25 million Medline 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.

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 enablers 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:

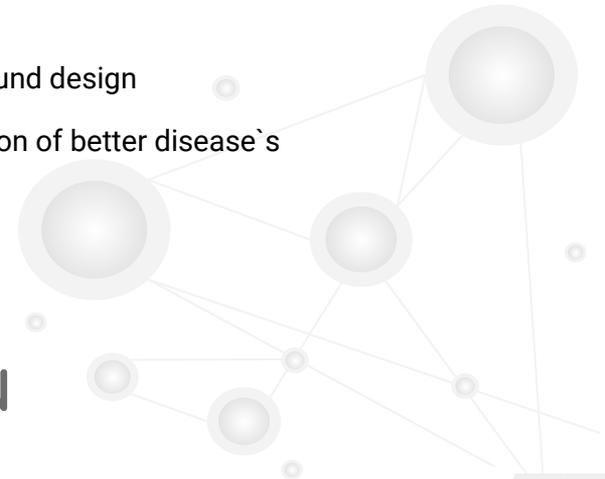


The way AI is used:

- 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



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:



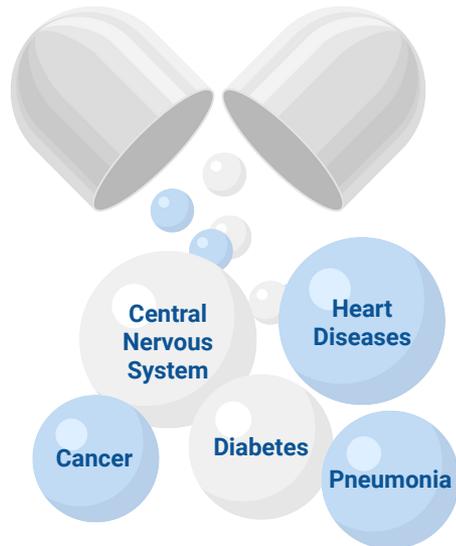
2. AI could revolutionise the way ophthalmologists diagnose diabetic macular edema (DME), a complication of diabetes that causes a thickening of the retina that can lead to irreversible blindness if left untreated. The best way to prevent DME is through regular eye exams that use a technique called colour 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.



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:

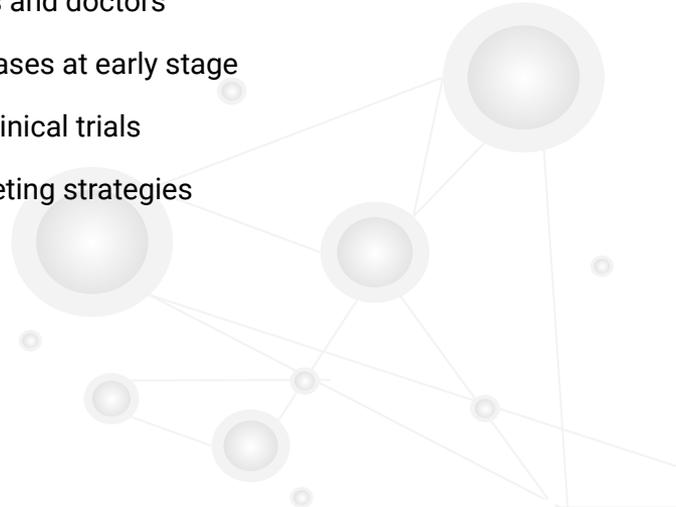


The way AI is used:

- 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



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.

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.

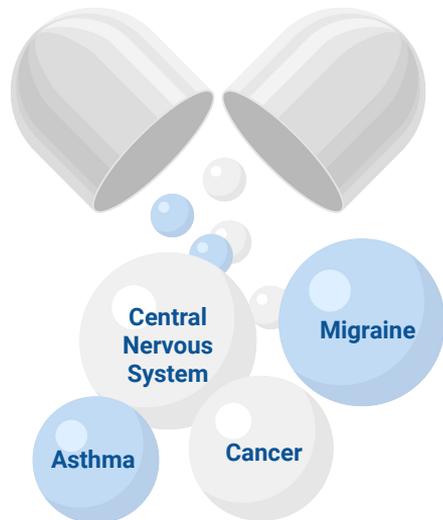
Most Innovative R&D Approaches of AI in Biopharma. Teva



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:

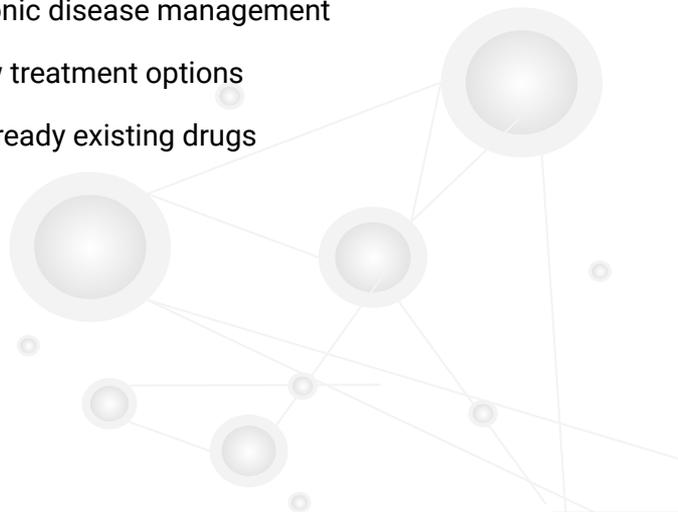


The way AI is used:

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

Cooperation:

- IBM Research



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.

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

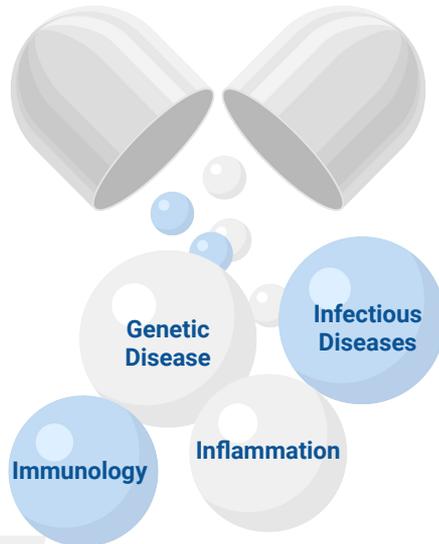


Recursion Pharmaceuticals is a digital biology company, which applies AI for the development of its drug discovery platform and pipeline.

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:

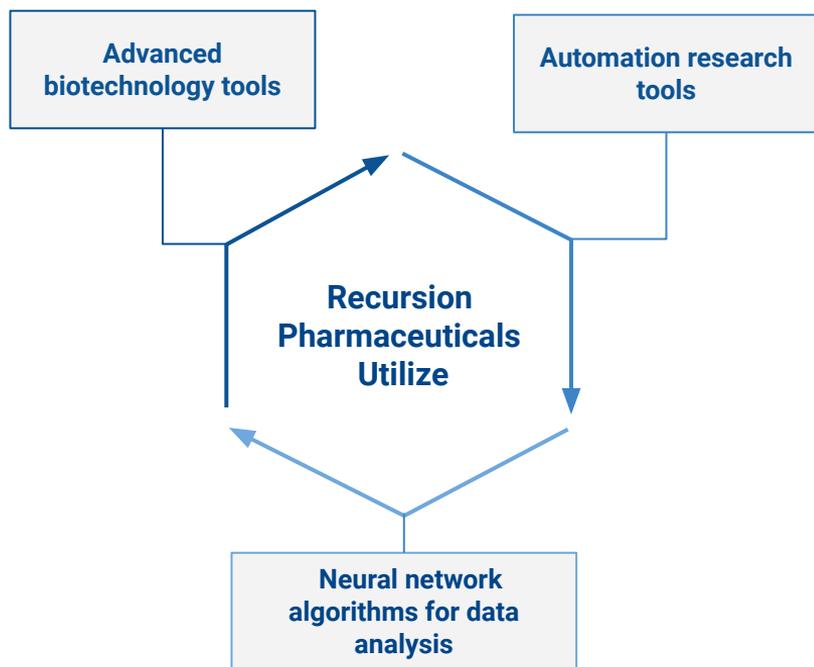
- **Infrastructure Layer** is a highly synchronized network created to design, execute, aggregate, and store biological and chemical data
- **Recursion Data Universe** is a high-dimensional biological and chemical dataset spanning multiple different data modalities
- **Recursion Map** is a software application 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 there are no approved therapies, or there are significant shortcomings with existing treatment paradigms.



To generate its datasets Recursion Pharmaceuticals is primarily focused on:

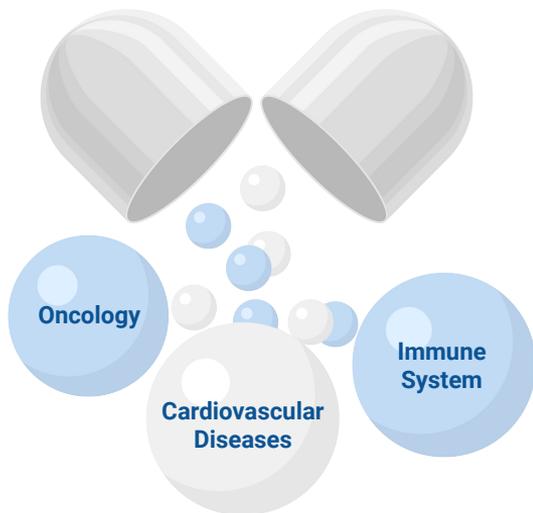
- **Advanced biotechnology tools** such as CRISPR genome editing and synthetic biology
- **Reliable automation** of complex laboratory research at unprecedented scale using advanced robotics
- **Iterative analysis** of, and inference from, large, complex in-house datasets using neural network architectures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

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



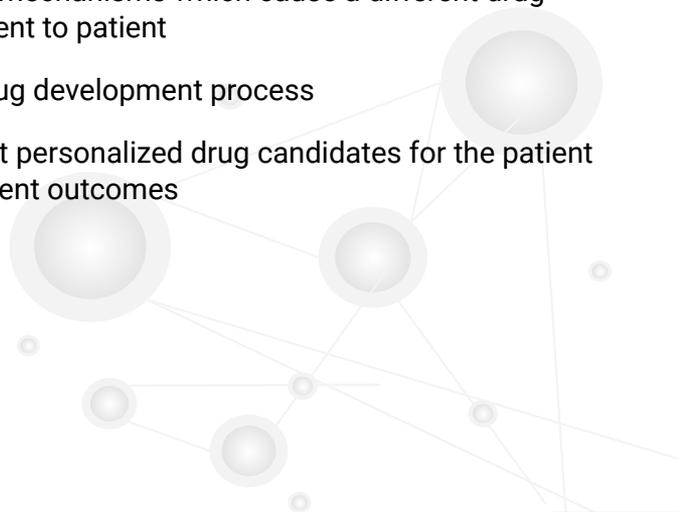
Owkin is a predictive analytics company that was founded based on the belief that medical research must be collaborative, inclusive and protect privacy. Today, Owkin is building a global research network leveraging federated learning that brings data scientists, physicians, researchers and pharmaceutical 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.

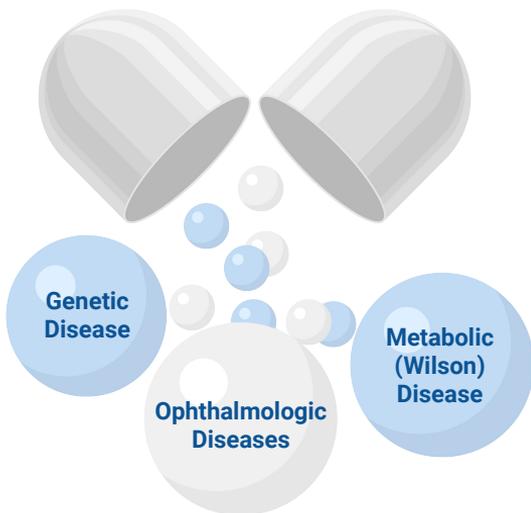
Most Innovative R&D Approaches of AI in Biopharma. Deep Genomics



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

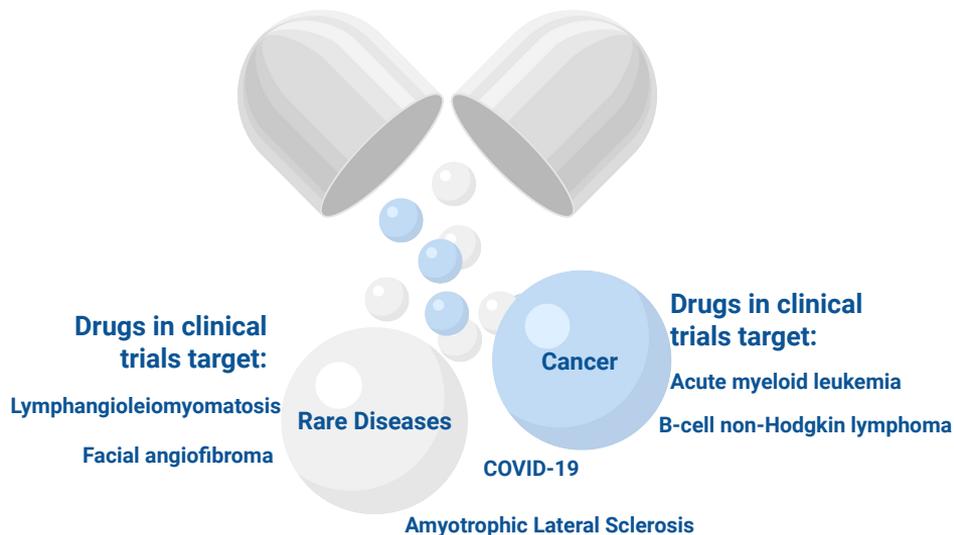
In Project Saturn, the Deep Genomics team used their platform to evaluate over 69 billion oligonucleotide molecules against 1 million targets *in silico*, to generate a library of 1000 compounds that were experimentally verified to manipulate cell biology.

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:



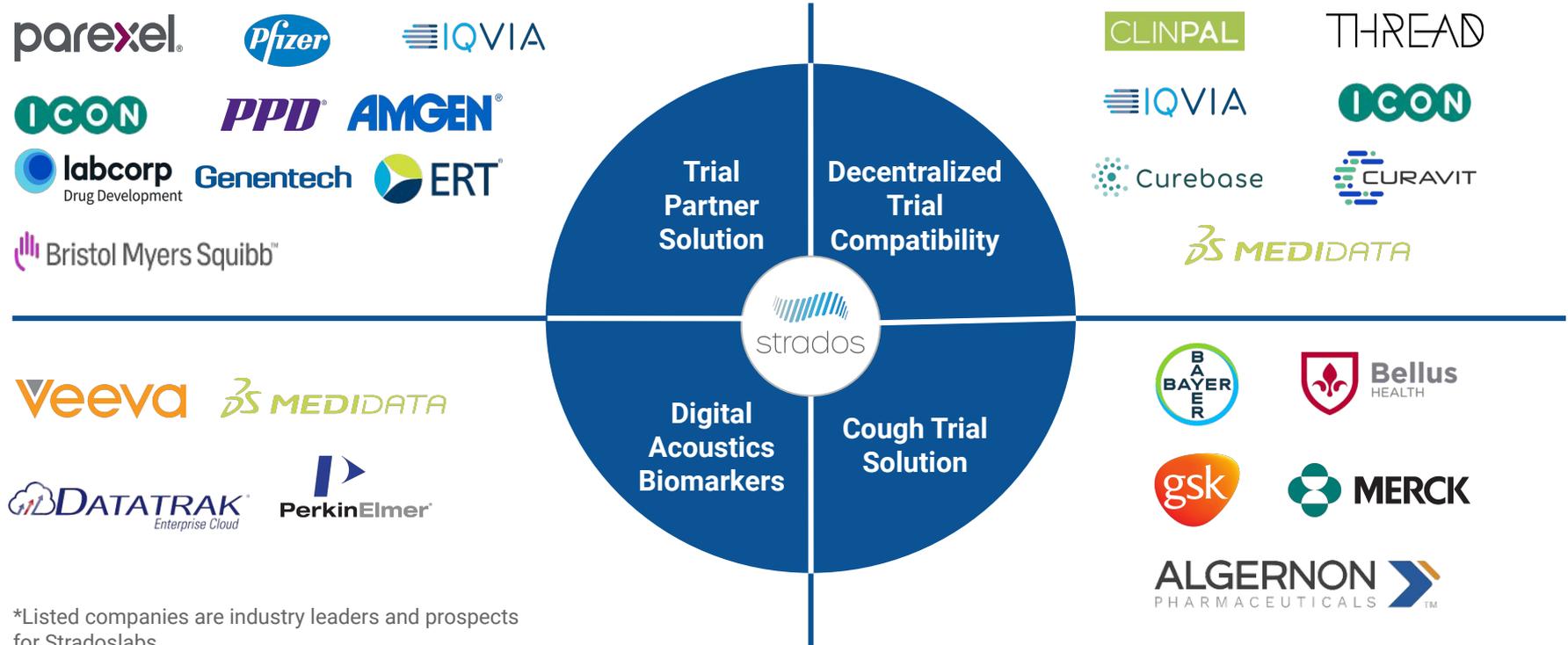
The way AI is used:

- 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.

Most Innovative R&D Approaches of AI in Biopharma. Strados Labs

Strados Labs enters the Pharma and Life Science market with a **Respiratory Management Solution** that includes the only FDA-cleared, RESP biosensor which acquires lung sound acoustics wireless and hands-free, making it a perfect fit for clinical research to measure patient response to new drugs by objectively collecting coughs and other lung sounds discreetly, comfortably, and securely in a streamlined way, while having access to data for post-processing and analysis.



*Listed companies are industry leaders and prospects for Stradoslabs

How Strados Labs Uses AI in R&D?



Strados Labs – a respiratory management solution, which brings innovation at the intersection of lung biomarkers, patient centricity, and machine learning. The industry of life sciences can largely benefit from the enhancement of pulmonary care monitoring capabilities provided by Strados Labs to gain insight into patient drug response by analysis of longitudinal lung acoustics.

220 hours of continuous data collection without patient intervention of objective lung sounds and respiratory dynamics while having access to data for post-processing and analysis.

Noise cancellation is applied to enhance the signal to noise ratio and eliminate speech discernibility while being HIPAA compliant with an end to end encryption.

Data collected via RESP is uploaded automatically to the Strados Cloud to allow assessment of recordings timely with identification of adventitious breath sounds including respiratory dynamics with ML algorithms.

Wireless, non invasive biosensor that monitors, records and stores every lung sound. That translates into longer wear times and an astounding 99.59% patient compliance.

Identification of wheeze, cough, and CABS detection gives the objective measurement of these changes over time on a patient and population basis with an ability to differentiate cough types in addition to frequency.

Data Collection Capacity

Patient Privacy & Security

Real-Time Data Analysis

Patient Centricity

Longitudinal Lung Data

How Strados Labs Uses AI in R&D?



The **Strados Respiratory Management Solution** is the world's first FDA-cleared lung sound platform with a proprietary wireless biosensor, **RESP**, that is passive, patient-friendly, and clinically validated to acquire lung sounds in the real world.

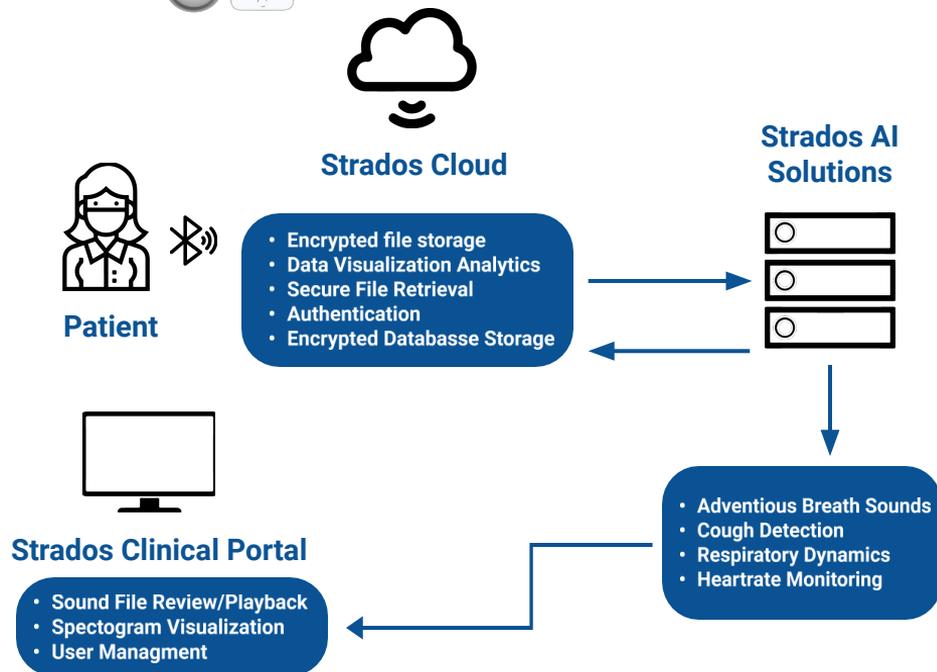
Today **Strados Labs** has a unique opportunity to stand as a leader in Respiratory Health: their clinically validated bioacoustic library of sounds and AI engine is the world's largest entirely hands-free, clinical-grade dataset enabling **Strados Labs** to be the standard bearer of acoustic digital biomarkers for clinical research and respiratory care globally.



For instance, **Strados Labs RESP** fits perfectly into decentralized trials allowing remote patient access by unlocking lung sound data and putting it into the hands of the entire research team via the cloud. Making decentralized respiratory trials scalable and able to develop entirely new insights about respiratory status without episodic patient interaction.

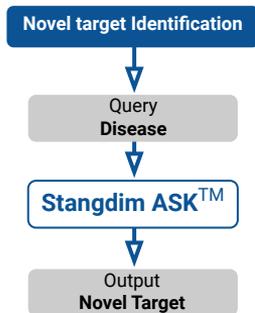


Strados Cloud: company's passive and longitudinal bioacoustics insights allow them to build a more complete picture of the subject's respiratory status leading to better trial outcomes.

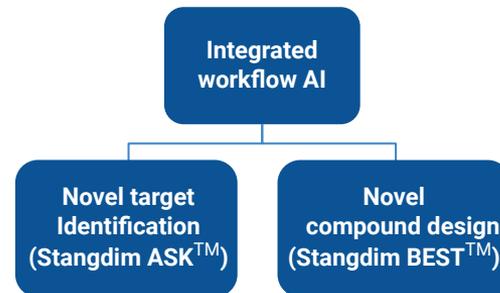


How Standigm Accelerates Drug Discovery using AI

Standigm's AI solution **Standigm ASK™** provides **novel targets** perfectly fit to a customer's research context within two weeks.



Standigm's optimized workflow **AI system** can generate **multiple First-in-Class** compounds within seven months.



Standigm has an exceptional reservoir of ready-made in-house **therapeutic assets**, which are as attractive as to meet customer's pipeline needs.

- Therapeutic areas of assets:



Cancer



Parkinson's Disease



NASH



Mitochondrial Disease

Novel Targets Identification

First-in-Class Lead Generation

Cataloged Assets

Tailored Partnership Models

Standigm

The workflow AI drug discovery company

Standigm has **tailored partnership models** perfectly fit to a customer's needs, from licensing of AI platform and assets to AI solution providing.

- Standigm's partnership models:

1. Licensing of Standigm's AI Platform (Standigm ASK™, Standigm BEST™)

2. Licensing of First-in-class assets driven by Standigm's AI platform

3. Providing Standigm's AI solution

How Standigm Accelerates Drug Discovery using AI

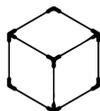
Standigm[®]

Standigm is a workflow AI-driven drug discovery company headquartered in Seoul, South Korea and subsidiarized in Cambridge, UK. Standigm has proprietary AI platforms encompassing novel **target identification to compound design**, to generate commercially valuable drug pipelines. The company has established an early-stage drug discovery workflow AI to generate First-in-Class lead compounds within seven months. o date, Standigm is running 42 in-house or collaborative pipelines for drug discovery using the workflow AI technology. One of the company's pipelines is expected to enter a pre-clinical stage in 4Q 2021.

Standigm BEST[™] is a novel **compound generation platform**, which can investigate lead compounds whenever target or ligand information is lacking or enough.

Standigm ASK[™] is a customizable, AI-aided **drug target identification platform**, prioritizing disease-target relationships and providing evidence-based results through an interactive user interface.

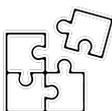
Database



Deep learning chemical space

150-dimensional vector space which learned various compound properties

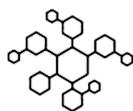
Hit ID



Securing activity

Accurate prediction of binding

Hit to Lead



Securing novelty

New scaffold with various structures

Lead Optimization



Druggability optimization

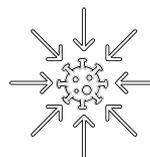
Mainly-based substructural variation 3D-based druggability prediction

Graph DB



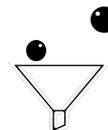
Biomap (Knowledge + Omics)

Prioritization algorithm



Target prioritization based on disease-target-association scores

Multi filters



Screening attractive target's with multi filters

Novel target selection

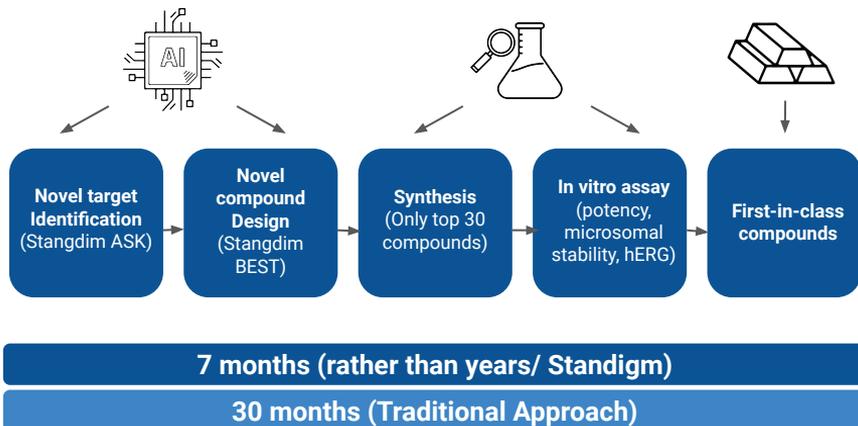


Novel Target Selection

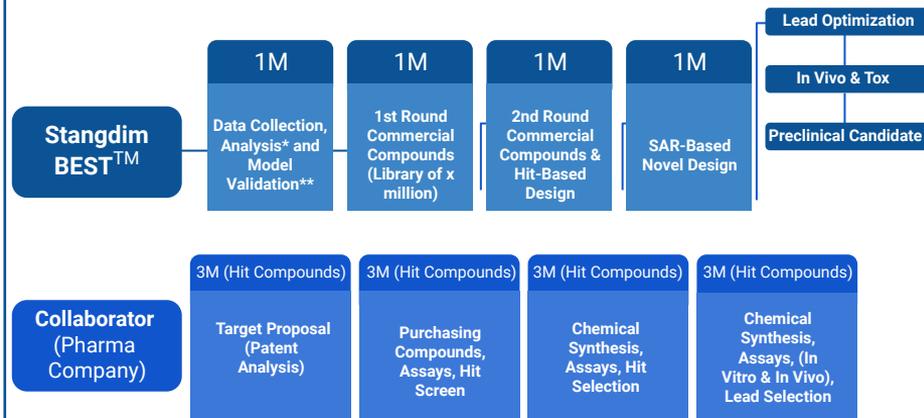
How Standigm Accelerates Drug Discovery using AI

Standigm Releases First-in-Class Compounds within 7 Months

Standardized workflow



Standigm made the hit-to-lead stage with a cancer Target A within 7 Months



*Data Analysis – Binding site analysis using protein structure

**Model Validation – Validation of activity prediction models

: ChemMap-based, 2D structure QSAR-based, Simulation-based and Ensemble-based methods

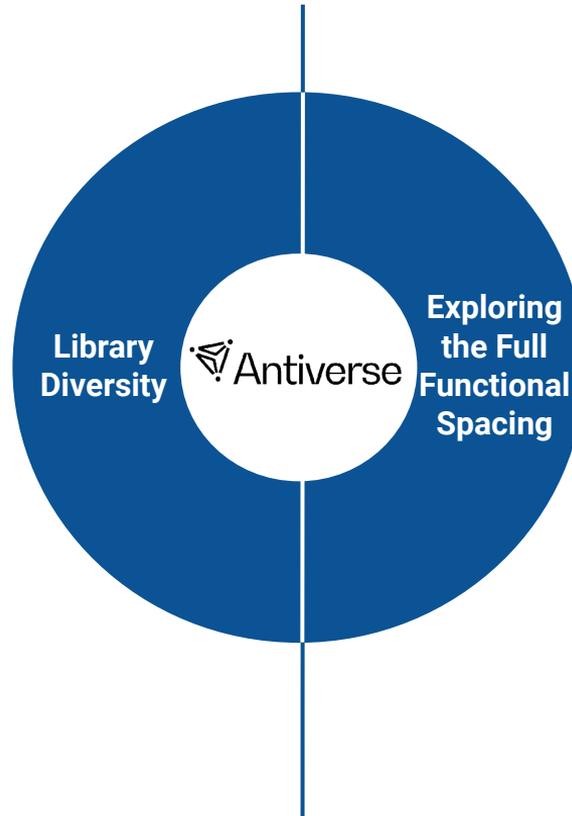
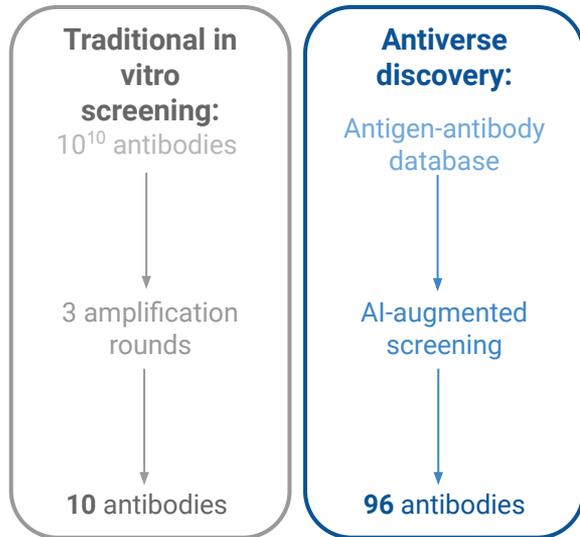
Featured Partners



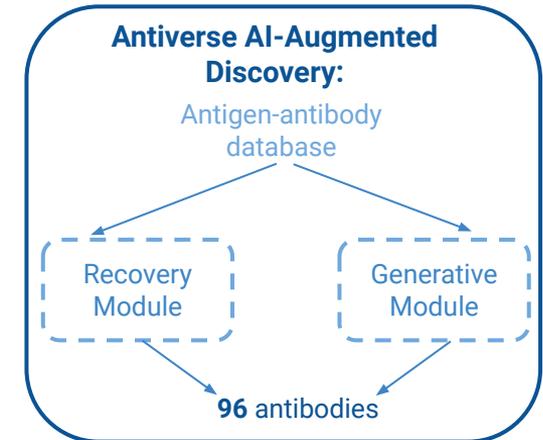
Most Innovative R&D Approaches of AI in Biopharma. Antiverse

Antiverse is a new type of antibody discovery company accelerating drug development. The Antiverse platform exists at the intersection of structural biology, machine learning and medicine to enable breakthroughs to happen more quickly and cost-effectively.

Antiverse **prevents diversity loss** during amplification to uncover more diverse and rare antibodies.



Antiverse **provides more candidates** by analysing NGS data, clustering on multi-dimensional space, and selecting based on sequential and structural grouping. The generative module **offers new sequences** and gives you options that haven't even been considered.



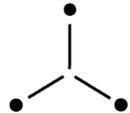
How Antiverse Engineers the Future of Drug Discovery



Antiverse is recognized as one of the top biotech startups in the UK with our antibody discovery service already in use by big pharma. The main feature of the company is **10x Diversity with AI-Augmented Drug Discovery**.

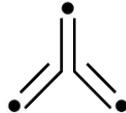
Existing antibody discovery methods are well-developed and often effective at discovering binders. But when there is a need to find the best possible candidate, or when finding a suitable candidate is hard with current methods, the options are **limited** and often **costly**.

Antiverse uses **next-generation sequencing (NGS)** to extract more data from existing workloads. The **AI-Augmented Drug Discovery platform** and trained models analyse the statistics gained from thousands of experiments. These outputs are compared against known data in order to select best candidates.



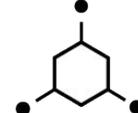
Target Selection

Antiverse provides targeted options in order to focus on testing safely once there are too many antibody-antigen binding options.



Binder Recovery

Antiverse can help to find sufficient potential binders that can be missed by conventional methods.



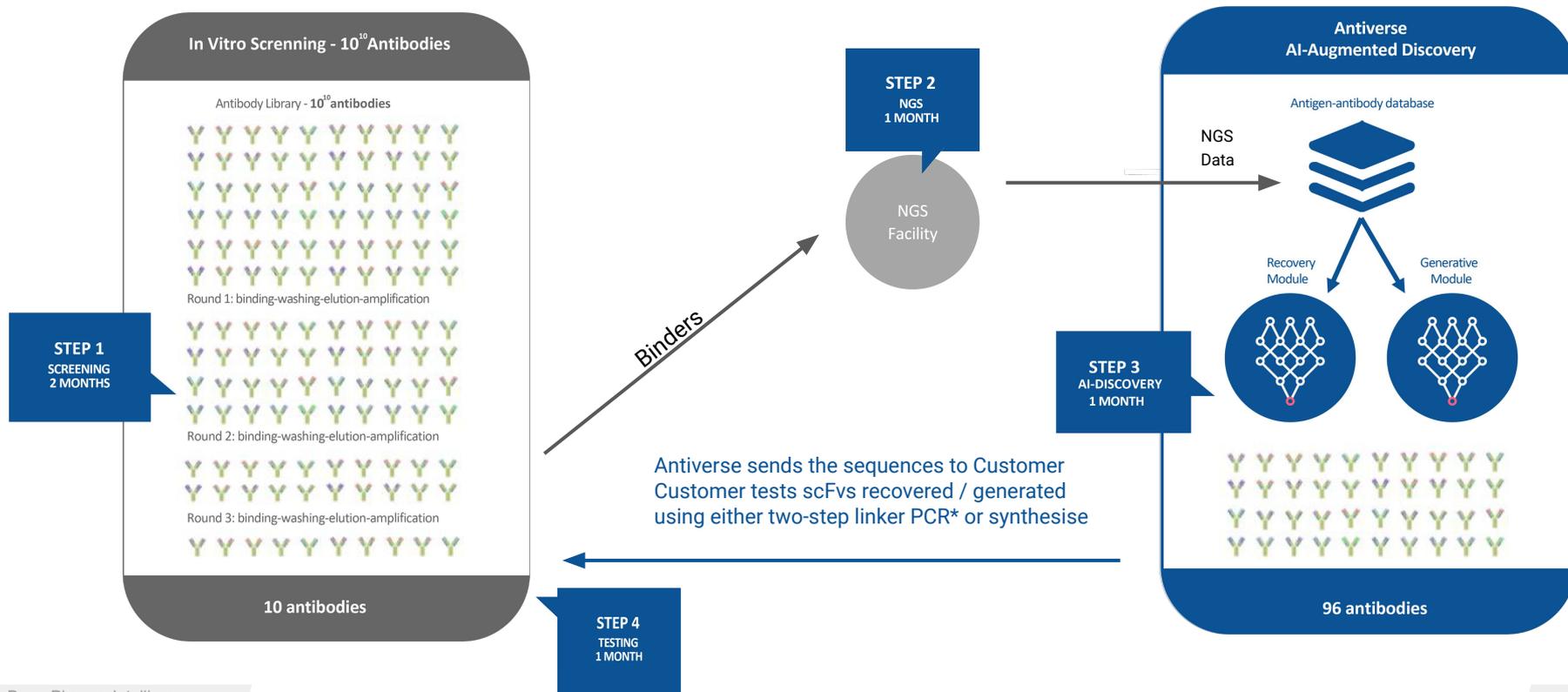
Binder Customisation

Antiverse can generate new binder variants that will be sufficient for clients purposes.

How Antiverse Uses AI in R&D

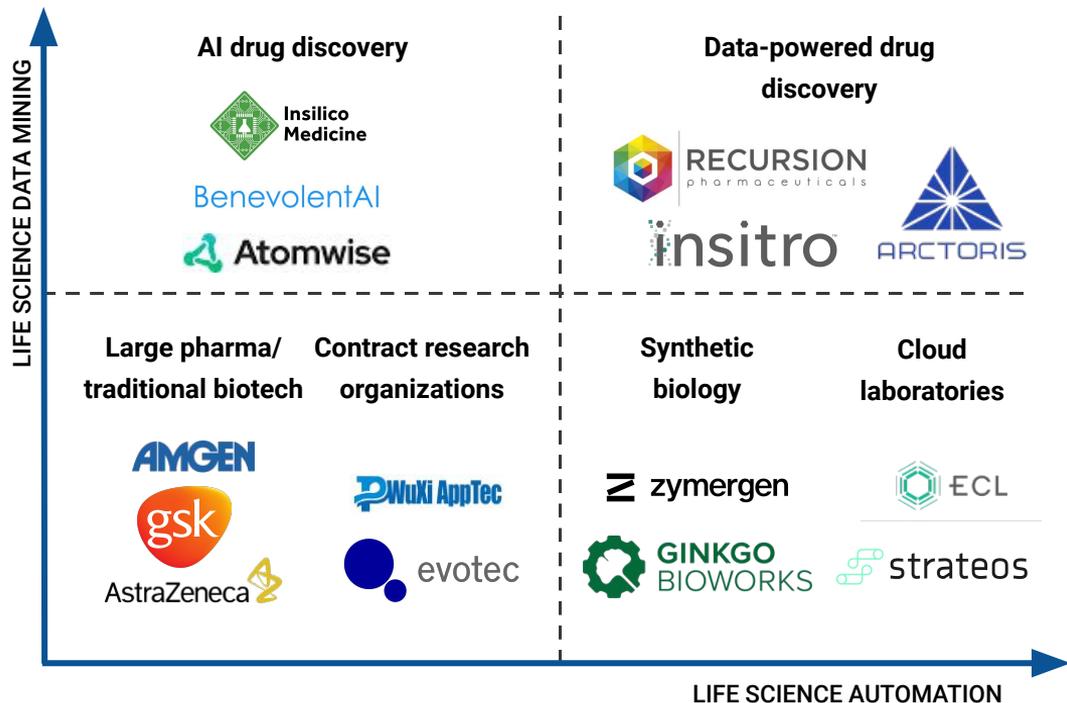


The Antiverse AI-ADD system found each and every cluster identified by other methods, plus more. These additional clusters contained rare and unique sequences.



The Drug Discovery Ecosystem is Evolving Rapidly - And Data is at the Core.

Drug discovery is undergoing massive and rapid change - the rise of Artificial Intelligence and Machine Learning for Drug Discovery and the evolution of robotics-centric companies in the biomedical research space has enabled a new generation of companies to emerge: **data-powered drug discovery companies** that combine automation and data science.



Arctoris is one of them: a biotech platform company with operations in Oxford, Boston, and Singapore, leveraging its **fully automated platform** for drug discovery.



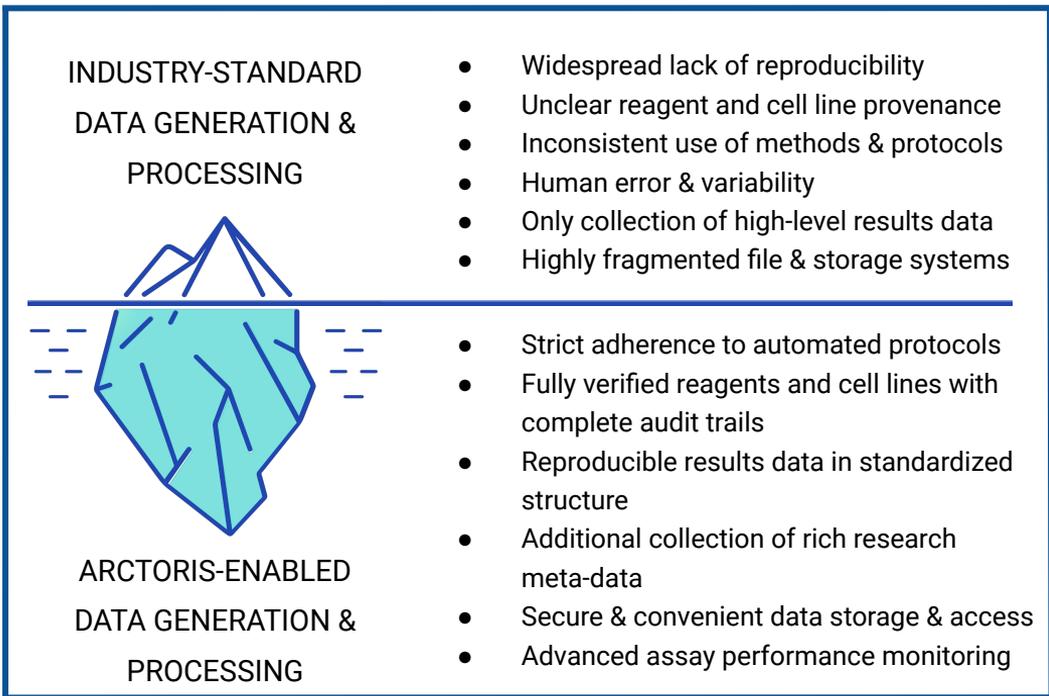
The company was founded by an oncologist and a medicinal/ synthetic chemist, with the goal to accelerate the discovery and development of new therapies by harnessing the power of technology and combining it with deep industry expertise.

The **core thesis** of the company is that better data leads to better decisions, and that in order for drug discovery programs to develop and meet the next milestone faster and with higher chance of success, the underlying data must be rich, reliable, and reproducible. According to Arctoris, **the status quo is no longer enough**: in order to develop the best drugs, industry leaders have to rethink how they can improve their decision-making, powered by better data.

Having developed a suite of proprietary technologies across robotics and data science/ AI/ ML, Arctoris is a leader in this **new and rapidly evolving field**.

How Do Robotics and AI/ ML Synergize in Drug Discovery?

The greatest challenge in AI-driven and ML-powered drug discovery is access to well structured, fully annotated, reproducible and robust data. **Arctoris** leverages the power of robotics to generate vast amounts of **ML-ready data that enable better decisions** - thereby significantly accelerating timelines from target to hit, lead, and candidate.



Both quality and speed are achieved by combining precision robotics with a unique data science platform and world-class drug discovery expertise from biotech and pharma veterans.

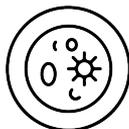
Arctoris tracks all experimental outputs in full depth, including the capture and analysis of extensive metadata – temperature, humidity, CO₂, reagent provenance and batch ID among many others. At the same time, the platform enables automated QA/ QC processing, applying statistical tools to ensure full reliability and validity of all results.

Thereby, Arctoris ensures **superior data to be generated in accelerated timeframes**, leading to better decisions taken earlier - in human-powered but especially in AI/ ML-driven programs, thanks to training of AI models with the best possible data.

Taken together, Arctoris has developed a **unique technology platform** based on robotics and data science that powers drug discovery programs both in the company's internal pipeline and in partnerships with biotech and pharma companies worldwide.

The Arctoris Platform: Leveraging Robotics & Data Science from Target to Candidate.

- Analysis of target expression and target half-life by quantifying protein turnover and route to degradation
- Investigation of target function (changes in phenotype, pathways, gene expression, etc.) via cell-based and molecular biology readouts
- Advanced insights into effects of target modulation by employing complex model systems such as organoids, primary cells, etc.



Target
Validation



Hit finding &
Hit-to-Lead

- Machine-learning guided screening set selection and hit evolution
- *In silico* and *in vitro* screening and profiling
- Biophysical screening/ profiling and FBDD
- Rapid synthetic hit expansion and diversification incl. use of CADD
- Kinetic and mechanistic biochemistry/ enzymology and biophysical quantitation of target engagement energetics & kinetics
- Protein science and (co)crystallography for SBDD

- Pharmacokinetics and pharmacodynamics (PK/ PD) & safety pharmacology
- In-depth pharmacokinetics, including ADME, drug-drug interactions, metabolite profiling, concentration time profiles
- Comprehensive acute toxicology assessment, incl. single dose and repeated dose to determine MTD and NOAEL
- Additional toxicology studies (e.g. reproductive and developmental toxicity, etc.)

Preclinical



Lead
Optimization



- Rapid biochemical profiling, kinetics, selectivity, mechanism of action
- Isolated and in-cell target engagement
- Cellular mode of action, elucidation of pathway modulation, confirmation of on-target/ off-target effect
- Medicinal and synthetic chemistry (optimizing SAR, SPR, STR)
- Integration of synthetic and computational chemistry as well as *in vivo* ADMET for late-stage lead optimization



Industry Developments 2020-2021



Biggest Deals Q1-Q3 2021

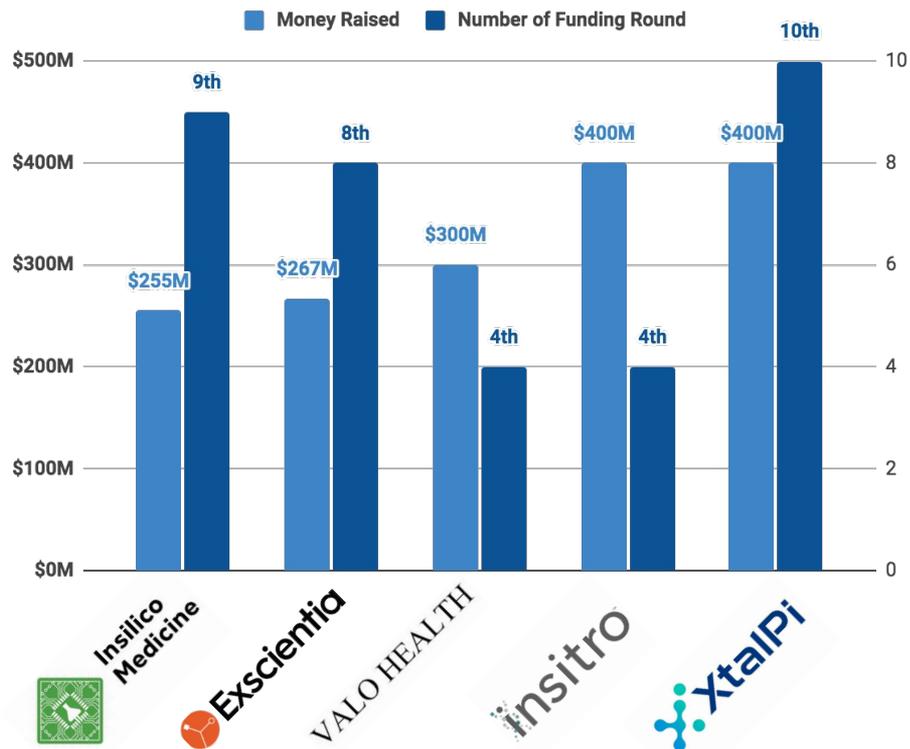
The total amount of VC funding in AI-biotech startups increased during Q3 of 2021 approaching a total of \$11.1B.

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. An important driver of growth for the sector is a substantial shift in Big Pharma's interest in AI technology, making AI an important integral part in the research and implementation areas.

Top 5 highest fundings received the following companies:

1. **Insitro** with \$400 million (Series C)
2. **Valo Health** with the sum of \$300M (Series A and B)
3. **Exscientia** with \$267 million (series D)
4. **Insilico Medicine** with \$255 million (Series C)
5. **XtalPi** with \$400 million (Series D)

Biggest Funding in Q1-Q3 2021



Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

The first drug developed using artificial intelligence by **Exscientia** in partnership with **Sumitomo Dainippon Pharma** is entering a Phase I clinical trial to treat obsessive-compulsive disorder.

Insilico will work with **Pfizer** to collect real-world data for targets in multiple therapeutic areas.

Scientists from **MIT** discovered one of the most potent antibiotics known to date using AI. The new antibiotic, called halicin, is able to kill 35 types of potentially deadly bacteria, including multi-resistant strains.

BenchSci raised \$22M in financial round B. The company also announced the launch of its new AI-powered reagent selection product and the expansion of the agreement with **Novartis**.

Jan 2020

Jan 2020

Jan 2020

Feb 2020

Feb 2020

Feb 2020

Feb 2020

Feb 2020

Feb 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.

Deep Genomics raised \$40M in Series B funding round.

Schrödinger enters a 5-year agreement with **Bayer** to work on a new platform for small molecule design. Schrödinger will provide ML and molecular design technologies, while Bayer will provide model for predicting the pharmacological properties of the molecules.

Schrödinger raised \$232M in IPO.

Lunit has raised \$26M in its series C. With the new financing, 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.

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

Alibaba Cloud launched a series of **AI solutions** to help fight the **coronavirus infection**, including Epidemic Prediction Solution, CT Image Analytics Solution, Genome Sequencing for Coronavirus Diagnostic Solution, and Elastic High-Performance Computing (E-HPC) Solution for Life Sciences.

Insilico collaborates with **Boehringer Ingelheim** to help to discover new targets.

Insitro, a machine learning-driven drug discovery company, raised \$143M in Series B financing.

Immunai has raised \$20M in a seed round to map the entire immune system. The startup combines machine-learning and single-cell technologies to map immune cells and their functions.

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.

Mar 2020

Schrödinger enters a 3-year collaboration with **Google Cloud** to leverage the supercomputer power for speeding up Schrödinger's molecular modelling platform.

Mar 2020

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.

Apr 2020

May 2020

AbCellera received \$105M Series B Financing. By applying AI, AbCellera is transforming the area of antibody discovery.

May 2020

May 2020

Owkin raised \$18M in Series A financing by Mubadala Capital and Bpifrance.

Jun 2020

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

Yale School of Medicine and **AI therapeutics** launched **Phase II clinical trials** of a new **anti-Sars-Cov-2 drug "LAM-002A"**. The drug (apilimod) has been shown to prevent the virus from entering cells. Previously, LAM-002A proved its safety for treating lymphoma and autoimmune diseases. It is being **repurposed** for coronavirus treatment.

Global Open Science project **COVID Moonshot** was launched by the international consortium of industrial and academic partners, including AI-driven start-up **PostEra**.

Atomwise raised \$123M in a round B led by **B Capital Group** and **Sanabil Investments**.

The **MELODY (Machine Learning Ledger Orchestration for Drug Discovery)** project initiated by ten major pharmaceutical companies achieved its first goal – deploying a drug discovery platform.

Jun 2020

Cyclica secured \$17M in financing round B. This start-up developed two platforms – Ligand Design and Ligand Express that predict molecular properties using deep learning technology.

Jul 2020

Lantern Pharma prepares for the start of **Phase II** and **Phase I clinical trials** of its two anti-cancer drug candidates. Both drug candidates were created using the **RADR® AI platform**.

Jul 2020

Jul 2020

IBM introduced a new cloud platform – **RoboRXN**, 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**.

Aug 2020

Aug 2020

Chinese tech giant **Baidu** plots an AI-baked drug discovery start-up, looking for investors to collectively infuse \$2B.

Sep 2020

Sep 2020

XtalPi has raised \$319M in funding round C, led by **SoftBank Vision Fund 2**, **PICC Capital**, and **MorningSide Venture Capital**.

Sep 2020

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

Exscientia teams up with **Huadong Medicine** for the **small molecules oncology program**. The project focuses on DNA damage repair and investigates the transcription control of DNA damage response genes, which disruption leads to mutation accumulations.

Nvidia has entered into a partnership with **GlaxoSmithKline (GSK)** and its AI group to discover drugs and vaccines.

Schrödinger has announced a discovery collaboration with **BMS** to discover, develop, and commercialize therapeutics in multiple disease areas.

Owkin announced a partnership with **the Institut Pasteur**. This partnership will focus on developing a new **ML model** capable of identifying **COVID-19** and any coronaviruses that could be used for future vaccines.

Sep 2020

Sep 2020

Sep 2020

Oct 2020

Oct 2020

Nov 2020

Nov 2020

Nov 2020

Nov 2020

Recursion Pharmaceuticals raises \$239M in a Series D funding round (\$50M from **Bayer**). Recursion has also entered into drug discovery collaboration with **Bayer** to develop new treatments against **fibrotic diseases of different organs**.

Insilico Medicine is launching a new target and drug discovery platform **Pandomics**. The platform enables to analyse and interpret OMICS data without having experience in bioinformatics and computational biology..

Taisho Pharmaceutical and **Insilico** have entered into a research collaboration to identify **novel therapeutics against aging**.

BioMarin and **Deep Genomics** have announced a partnership on **AI rare disease drug discovery**. Deep Genomics will provide its AI drug discovery platform to identify and validate targets and leads. At the same time, BioMarin will be responsible for preclinical and clinical development.

Insilico Medicine has announced that it has entered into a multi-target drug discovery agreement with **Janssen Pharmaceutical N.V.**

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

Insilico partnered with **APRINOIA** on **AI-powered neurodegenerative drug discovery**. The partnership aimed to utilise Insilico's generative AI technology to accelerate the discovery of compounds targeting abnormal proteins in the brain associated with neurodegenerative diseases.

Nucleai and **Debiopharm** announced that they have entered into a long-term collaboration to leverage Nucleai's **AI-powered biomarker research** & discovery platform for one of Debiopharm's clinical-stage oncology assets.

AstraZeneca announced a collaborative agreement with **AliveCor**. The partnership will revolve around **AliveCor's Kardia-K AI**, which is designed to analyze **ECGs** to measure a patient's **potassium levels**.

Insitro has raised \$400M in a Series C financing.

Nov 2020

BioNTech SE and **InstaDeep Ltd** announced a multi-year strategic collaboration to apply for the latest advances in AI&ML to develop **novel immunotherapies** for a range of cancers and infectious diseases.

Dec 2020

Jan 2021

Boehringer Ingelheim announced a collaborative agreement with **Google Quantum AI**, focusing on researching and implementing cutting-edge use cases for quantum computing in pharmaceutical R&D.

Jan 2021

The **Jameel Clinic** and **Sanofi** announced collaboration on the development and application of AI to revolutionize healthcare and advance impactful and effective drug development.

Jan 2021

Feb 2021

Iktos announced the application of Iktos Artificial Intelligence technology for de novo design to selected **Pfizer** small-molecule discovery programs.

Mar 2021

Mar 2021

Antiverse has raised £1.4M in seed funding to develop further its artificial intelligence (AI) antibody drug discovery platform

Mar 2021

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

NVIDIA and **AstraZeneca** revealed a new drug-discovery model called **MegaMolBART**, which is aimed at "reaction prediction, molecular optimisation and de novo molecular generation."

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.

StoneWise has completed its series B and series B+ investment rounds, raising a total of \$10M.

Lantern Pharma collaborates with **Actuate Therapeutics**. The partnership will focus on leveraging Lantern Pharma's ML technology, large-scale oncology datasets, and the AI platform to accelerate critical aspects of **Actuate's 9-ING-41 drug candidate**.

Mar 2021

Amgen announced that it has entered into a multi-year partnership with **Mila** – Quebec Artificial Intelligence Institute.

Apr 2021

NVIDIA announced a strategic partnership with **Schrödinger** to **expand speed and accuracy of Schrödinger's computational drug discovery platform** and enable rapid, accurate evaluation of billions of molecules for the potential development of therapeutics.

Apr 2021

Apr 2021

Medable Inc. has obtained \$78M in new capital to accelerate the industry's transformation by advancing the delivery of digital and decentralised clinical trials.

Apr 2021

Apr 2021

PharmCADD, a drug discovery firm based on artificial intelligence and physics in Busan, South Korea, has raised \$16B in Series B funding.

Apr 2021

May 2021

BMS has agreed to pay up to \$1.2B to enter a drug discovery collaboration with **Exscientia**.

May 2021

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

PathAI has raised \$165M in a recently completed Series C round. **D1 Capital Partners** and **Kaiser Permanente** co-led the funding.

Iktos announced a Research Collaboration Agreement with **Kadmon**. Iktos's generative modelling **AI technology** will be used to enable the rapid and cost-effective design of novel drug candidates for an undisclosed Kadmon drug discovery program.

eTherapeutics has successfully placed shares on the stock market, raising another £22.5M.

Molecule.one, a Polish computational chemistry firm, has acquired \$ 4.6M to continue its quest to develop theoretical medicinal compounds.

May 2021

CytoReason announced a partnership with **Ferring Pharmaceuticals** to establish new treatments for **inflammatory bowel disease (IBD)**.

May 2021

AcuraStem has received an **ALS Research Program Therapeutic Development Award** from the Department of Defense, Congressionally Directed Medical Research Programs totalling \$1 million.

May 2021

May 2021

Aetion, a healthcare technology business, announced a \$110M Series C fundraise led by **Warburg Pincus**.

May 2021

May 2021

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.

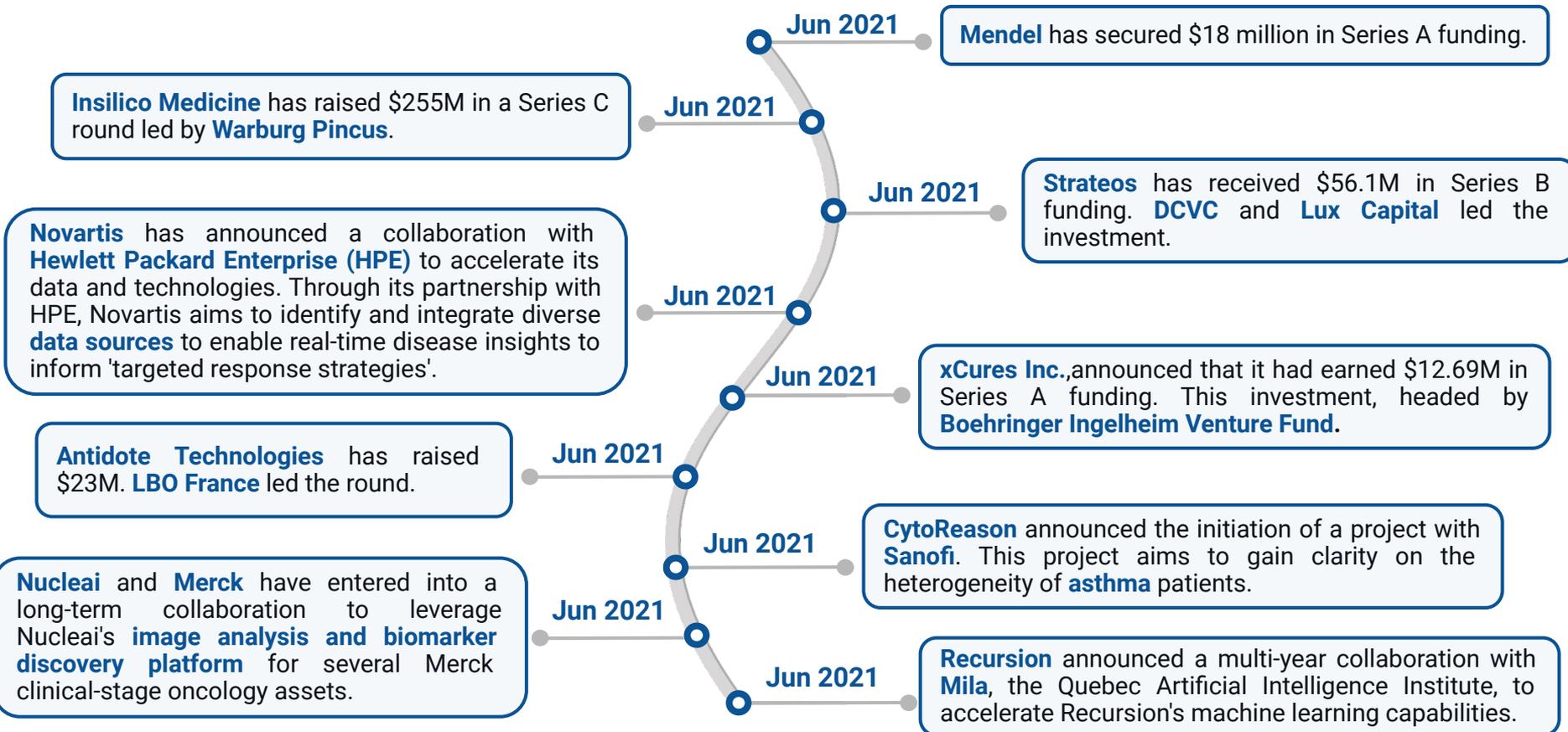
May 2021

May 2021

Causaly, London's AI/ML platform that connects all the dots in a flash, raised \$17M in a Series A investment headed by **Index Ventures**.

May 2021

Selected Pharma AI Industry Developments Q1 2020 – Q4 2021



Selected Pharma AI Industry Developments Q1 2020 – Q4 2021

Sosei Group Corporation and **InveniAI® LLC** announced the initiation of a new R&D collaboration. The partnership aims to identify new therapeutic product concepts for **immune diseases** where an **AI approach** can be applied to generate evidence for the role of G-protein coupled receptors in relevant immunomodulatory pathways.

BMS has exercised an option on an **immune-modulating drug** candidate developed by **Exscientia**, paying \$20 million for the buy-in as part of their \$1.2 billion alliance.

The **Institute of Cancer Research (ICR)** in London used **AI** to identify the **most promising drug combinations** for children with incurable brain cancer.

AstraZeneca, Merck, Pfizer and **Teva** formed **AION Labs**, the innovative lab that will create and adopt **AI technology** to **transform the process of drug discovery**.

Jul 2021

Eli Lilly has entered a three-year partnership with biotech company **Verge Genomics** to research and create new drugs to treat **amyotrophic lateral sclerosis (ALS)**.

Jul 2021

Insilico Medicine in collaboration with **4B Technologies** aims to find a cure for **amyotrophic lateral sclerosis (ALS)**.

Aug 2021

Aug 2021

Standigm opened a new office in **Cambridge, UK**, to accommodate the company's rapid growth in the **European market**. With its corporate headquarters in **Seoul, South Korea**, the opening of this new office is consistent with Standigm's growth strategy to deepen its global footprints. It will enable Standigm to have a physical presence in the **European market**.

Aug 2021

Sep 2021

Signet Therapeutics and **XtalPi Inc.** announced the AI drug discovery collaboration on a program against a novel cancer target identified by Signet.

Oct 2021

Oct 2021

AI drug discovery startup Quris launches with \$9M to predict drug success starting with rare diseases. The Quris initial focus is on rare genetic diseases that can't be modeled in animals.

Oct 2021

Key Takeaways



Major Observations for Q1-Q4 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-Q4 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. Q3 of 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 **\$38.3B of cumulative capitalization** as of October 20 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.

AI on different steps in DD

AI is used not only for drug design, but also target identification

AI platforms yield successful results

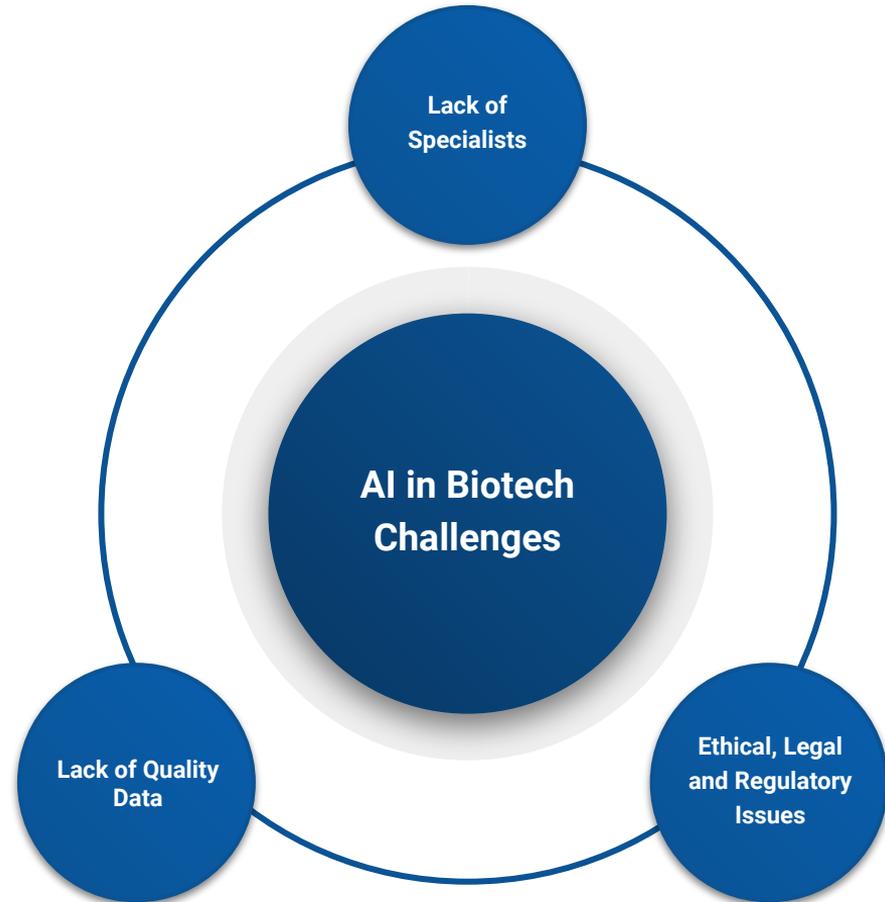
Many AI-designed drugs showed successful results in research studies and even clinical trials

AI democratizations

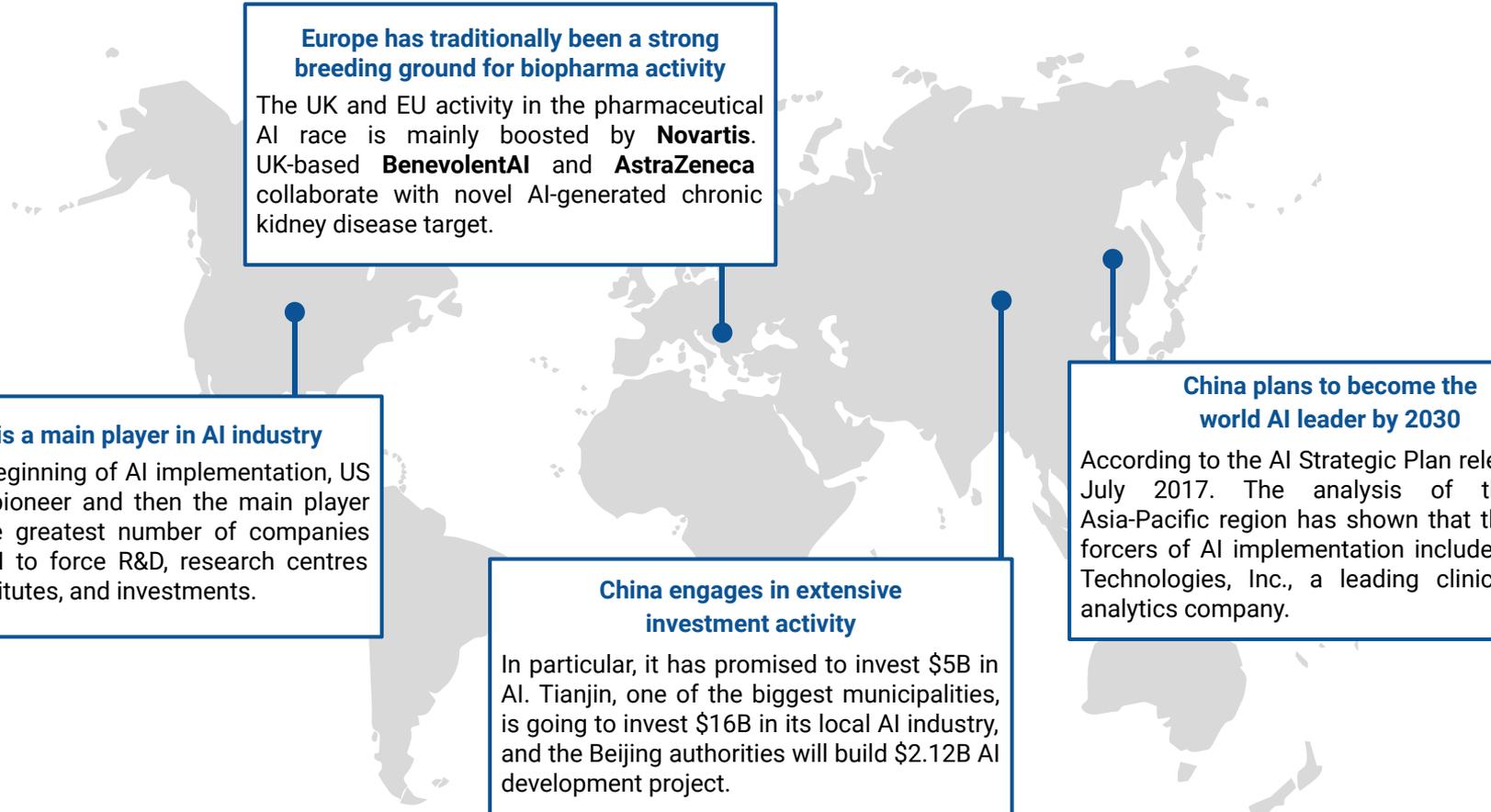
Ready-to-use AI platforms for DD became available and can be used by non-AI experts

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



Europe has traditionally been a strong breeding ground for biopharma activity

The UK and EU activity in the pharmaceutical AI race is mainly boosted by **Novartis**. UK-based **BenevolentAI** and **AstraZeneca** collaborate with novel AI-generated chronic kidney disease target.

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.

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 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.

Appendix: List of Entities

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

1	3Analytics
2	3BIGS
3	4G Clinical
4	A2A Pharmaceuticals
5	AccutarBio
6	Acellera
7	Actimus Biosciences
8	AcuraStem
9	ADMdx
10	Aegicare
11	Aetion
12	AHEAD Medicine
13	AI Therapeutics
14	AiCure
15	Aiforia
16	Aigenpulse
17	AILON
18	Aizon
19	Alector
20	Alembic Pharmaceuticals

21	AlgoDx
22	AliveX Biotech
23	Alkahest
24	Allelica
25	Almirall
26	Alphanosos S.A.S.
27	Altis Labs
28	Amplion
29	Ancora.ai AG
30	Anima Biotech
31	Antidote.me
32	Antiverse
33	ApexQubit
34	Aqemia
35	Arbor Biotechnologies
36	Arctoris
37	Ardigen
38	Ares Genetics GmbH
39	Aria Pharmaceuticals
40	ariadne ai

41	Ariana Pharma
42	ARONTIER
43	Arpeggio Bio
44	Arrakis Therapeutics
45	Arzeda
46	Astellas Pharma
47	Astex
48	Asymchem Laboratories (Tianjin)
49	Athelas
50	Atomwise
51	Auransa
52	Banjo Health
53	BenchSci
54	BenevolentAI
55	Berg
56	Berkeley Lights
57	BigHat Biosciences
58	BIOAGE LABS
59	BioBetter
60	BioCentury

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

61	Biodesix
62	BioDuro
63	Biofourmis
64	Biologic Design
65	Biomatter Designs
66	Biomea Fusion
67	Biorelate
68	Biosortia Microbiomics
69	BioSymetrics
70	bioSyntagma
71	biotx.ai
72	Biovista
73	BioXcel Therapeutics
74	Bioz
75	Boehringer Ingelheim
76	Brickell Biotech
77	Bristol Myers Squibb
78	Brite Health
79	BullFrog AI
80	C4X Discovery

81	Calico
82	Cambridge Cancer Genomics
83	CaroCure Discovery Solutions Private Limited
84	Causaly
85	Celeris Therapeutics
86	Cellarity
87	CellPly
88	Cellter
89	Celsius Therapeutics
90	Centaura
91	ChemPass Kft
92	Cipla Medpro South Africa Ltd.
93	Clinigen Group
94	Clinithink
95	Cloud Pharmaceuticals
96	CloudMedx
97	Clover Therapeutics
98	Collaborations Pharma
99	Collective Scientific, LLC
100	Concerto Healthcare

101	Coral Genomics
102	Cotinga Pharmaceuticals
103	Cunesoft GmbH
104	Cyclica
105	CytoReason
106	Cytox
107	Dainippon Sumitomo Pharma
108	Data2Discovery
109	Data4Cure
110	DataClue.io
111	Datavant
112	Dayton Therapeutics
113	Deep 6 AI
114	Deep Genomics
115	Deep Intelligent Pharma
116	Deep Lens
117	DeepMatter Group
118	DeepMind
119	Denovicon Therapeutics
120	DEXSTR

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

121	DNAnexus
122	Doc.ai
123	Easemedcontrol
124	Edifice Health
125	Eigengene
126	Elucidata
127	Emedgene
128	Emerald Cloud Lab
129	Empiric Logic
130	Engine Biosciences
131	EntheogeniX Biosciences
132	Envisagenics
133	ePharmaSolutions
134	Epistemic AI
135	Erasca
136	eTherapeutics
137	Eularis
138	Euretos
139	Evaxion Biotech
140	Everest Medicines

141	Evestra Onkologia
142	Evid Science
143	Evolutionary Genomics
144	Evotec
145	EVQLV
146	Exogene
147	Exscientia
148	Fabric Genomics (formerly Omicia)
149	FAR Biotech
150	FDNA
151	Fibronostics
152	Flagship Biosciences
153	Flatiron Health
154	Foundation Medicine
155	Frontage Holdings
156	Frontier Medicines
157	Fulmz AI
158	G3 therapeutics
159	Gatehouse Bio
160	Genentech

161	Genesis Therapeutics
162	GENFIT
163	Genialis
164	Genome Biologics
165	Genuity science
166	Gero
167	Globavir
168	GlucoGear
169	GNS Healthcare
170	Gordian Biotechnology
171	Gritstone Oncology
172	GT Apeiron Therapeutics
173	Guided Clarity
174	Health Nucleus
175	HealthMatch
176	Healx
177	HelixAI
178	Herophilus
179	Hinge Therapeutics
180	Histoindex

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

181	HistoWiz
182	HK inno.N Corp
183	Huma
184	human API
185	iCarbonX
186	iClinical Inc
187	icomatrix
188	IDEAYA Biosciences
189	Iktos
190	Imagia
191	Imaginostics
192	Immunai
193	ImmunoMind
194	Inato
195	Indegene
196	Infinite Intelligent Pharma
197	Ingentium
198	Innophore
199	Innoplexus
200	Insilico Medicine

201	Insitro
202	Intellegens
203	Intelligencia
204	Intelligent OMICS
205	Interprotein
206	Intomics
207	InveniAI
208	Ionis Pharmaceuticals
209	Ipsen
210	IQVIA
211	Iridia
212	Iris.ai
213	ITeos Therapeutics
214	JADBio
215	Juvena Therapeutics
216	Keeneye
217	Kite Pharma
218	Kuano
219	KYAN Therapeutics
220	Kyndi

221	LabGenius
222	LabTwin
223	Lantern Pharma
224	Leucadia Therapeutics
225	Linguamatics
226	Longenesis
227	Lundbeck
228	MABSilico
229	Massive Bio
230	Medable
231	MedAware Systems
232	MediBIC Group
233	MediRita
234	MedView Technologies
235	Mendel.AI
236	Menten AI
237	Meta
238	mettleAI
239	Micar Innovation (Micar21)
240	Mitsui E&S Systems Research

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

241	MNM Bioscience Inc.
242	MNM Diagnostics
243	Modulus Therapeutics
244	Molecular Fingerprint
245	Molecule.one
246	Molomics Biotech SL
247	MultiCASE
248	Nanna Therapeutics
249	Nashville Biosciences
250	NBD Nostrum Biodiscovery
251	NetraMark
252	Neumora Therapeutics
253	Neuron23
254	NeuScience
255	nference
256	Nimbus Therapeutics
257	Notable
258	Notable Labs
259	Novadiscovery
260	Novo Nordisk

261	Novoheart Holdings
262	nQ Medical
263	Nucleai
264	NuMedii
265	Nurenyx Inc.
266	Nuritas
267	Nuventra acquired by CATO SMS
268	ObvioHealth
269	OccamzRazor
270	Ochre Bio
271	OKRA Technologies
272	Olaris
273	Oncocross
274	Onegevity Health
275	OneThree Biotech
276	Optibrium
277	Owkin
278	Paradigm4, inc.
279	PatchAi
280	PatSnap

281	PEACCEL
282	Pending.AI
283	Pepticom Ltd.
284	Peptone
285	Pera Labs
286	Percayai
287	Perceiv AI
288	Perceiv Research
289	Pharmacelera
290	pharmAI
291	Pharmaledger
292	PharmCADD
293	Pharnext
294	Pharos iBT
295	Phenomic AI
296	Phenomix Health
297	pixyl
298	Plex Research
299	Polaris Quantum Biotech
300	PostEra

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

301	Precision Life
302	Predictive Oncology
303	Presagen
304	Prognica Labs
305	Proscia
306	Protea Biosciences
307	ProteinQure
308	Quertle
309	Quibim
310	Qview Medical
311	Qynapse
312	RECEPTOR.AI
313	Recursion Pharmaceuticals
314	Relay Therapeutics
315	Remedium
316	Renalytix AI
317	Repurpose.AI
318	Researchably
319	Resonant Therapeutics
320	Retinal

321	Reveal Biosciences
322	Reverie Labs
323	ReviveMed
324	Ro5
325	Roivant Sciences
326	Saama
327	Sage Bionetworks
328	Sage-N Research
329	Sangamo Therapeutics
330	Satalia
331	Scailyte
332	Schrödinger
333	sciNote
334	Segmed
335	SEngine Precision Medicine
336	Sensyne Health
337	Sigma Technologies, Ltd.
338	Silexon
339	Simply Speak
340	Simulations Plus

341	Sirenas Marine Discovery
342	SOCIUM Inc
343	SOM Biotech
344	Somalogic
345	SOPHiA GENETICS
346	Sopris Health
347	Sparrho
348	Spectral MD
349	Spring Discovery
350	Standigm
351	Steel Therapeutics
352	StoneWise
353	Strados Labs
354	Strata oncology
355	Strateos
356	Structura Biotechnology
357	StuffThatWorks.health
358	Synergy Pharmaceuticals
359	Synsight
360	Syntekabio, Inc.

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

361	Synthace
362	Systems Oncology
363	TARA Biosystems
364	Tempus
365	TeselaGen
366	ThoughtSphere Inc.
367	ThoughtSpot
368	Tracked.bio
369	Transcenta
370	TrialJectory
371	Trials AI
372	Turbine
373	Ultromics
374	Unlearn.AI
375	Unnatural Products
376	Valence Discovery
377	Valo Health
378	Variational AI
379	Veradigm
380	Verge Genomics

381	VeriSIM Life
382	Virogin Biotech
383	VitalHub
384	Vivia Biotech
385	Volta Medical
386	Vyasa Analytics
387	Wave Life Sciences
388	Winterlight Labs
389	Wisecube
390	WuXi AppTec
391	X-37
392	Xbiome
393	xCures
394	XtalPi
395	Zebra Medical Vision

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

1	77
2	10x Group
3	11.2 Capital
4	180 Degree Capital
5	360 Capital
6	3i Group
7	3Lines
8	4FO Ventures
9	500 Startups
10	500 Startups Canada
11	5AM Ventures
12	5Y Capital
13	6 Dimensions Capital
14	7BC Venture Capital
15	8VC
16	A-Level Capital
17	A&E Investments
18	AbbVie
19	AbbVie Biotech Ventures
20	Abstract Ventures

21	Acadia Woods Partners
22	Accel X
23	Accelerate Long Island
24	Accelmed
25	Access Biotechnology
26	Access Industries
27	Access Ventures
28	ACE & Company
29	Acequia Capital (AceCap)
30	ACF Investors
31	ACME Investments
32	Acorn Bioventures
33	Adage Capital Management
34	Adara Ventures
35	Advantage Capital
36	Advent Life Sciences
37	Afore Capital
38	Agent Capital
39	AI Seed
40	Air Street Capital

41	Aisling Capital
42	AJS Investments
43	Alcazar Capital
44	Alchemist Accelerator
45	Alexandria Real Estate Equities
46	Alexandria Venture
47	Alexandria Venture Investments
48	AllBright
49	Allen & Company
50	Allen Institute for Artificial Intelligence
51	Allianz Life Ventures
52	Ally Bridge Group
53	Almanack Family Office
54	Alpha Intelligence Capital
55	AlpInvest Partners
56	ALS Investment Fund
57	Alta Partners
58	Altitude Life Science Ventures
59	Alumni Ventures Group
60	Alychlo

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

61	Amadeus Capital Partners
62	Amazon Alexa Fund
63	AME Cloud Ventures
64	Amgen
65	Amgen Ventures
66	Amidi Group
67	Amino Capital
68	aMoon Fund
69	AMOREPACIFIC Ventures
70	Amplify Capital
71	Amplify Partners
72	Amplify.LA
73	Amplitude Venture Capital
74	Andreessen Horowitz
75	AngelPad
76	Angels 5K
77	Angels Capital
78	Angels in MedCity
79	Anges Quebec
80	Aperture Venture Partners

81	APEX Ventures
82	Aravis Ventures
83	Arboretum Ventures
84	ARCH Venture Partners
85	ARK Investment Management
86	ARPA-E
87	ArrowMark Partners
88	Artis Ventures (AV)
89	Asahi Kasei
90	Asas Capital
91	Ascend Capital Partners
92	Asset Management Ventures (AMV)
93	Asset One
94	Astia Angels
95	ATAI Life Sciences
96	ATEM Capital
97	Atinum Investment
98	Atlantic Bridge
99	Atlas Venture
100	Atmos Ventures

101	Atomico
102	AV8 Ventures
103	Avidity Partners
104	Aviva Ventures
105	Axel Investments
106	B Capital Group
107	Babel Ventures
108	BACKED VC
109	Baidu Ventures
110	Baillie Gifford
111	Baird Capital
112	Bakken & Baeck
113	Balderton Capital
114	Bangarang Group
115	Bank of China
116	Bank of Hangzhou
117	Bantam Group
118	Baron Capital Management
119	Basis Set Ventures
120	Bay City Capital

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

121	BB Biotech Ventures
122	BDC Healthcare Venture
123	BDC Venture Capital
124	Beast Ventures
125	Ben Franklin Technology Partners of Southeastern Pennsylvania
126	Bend Venture Conference
127	Beresford Ventures
128	Berggruen Holdings
129	Berkeley SkyDeck Fund
130	Better Ventures
131	Bezos Expeditions
132	BGS Venture
133	BIG BOOSTER
134	Big Pi Ventures
135	Bill & Melinda Gates Foundation
136	Bioeconomy Capital
137	Biomatics Capital Partners
138	Bios Partners
139	Biospring Partners
140	Biotechnology Value Fund

141	BioVenture
142	Bioverge
143	Black Diamond Ventures
144	BlackRock
145	BlackRock Innovation Capital
146	Blackstone Accelerates Growth
147	Block.one
148	Bloomberg Beta
149	Blue Bear Ventures
150	Blue Ivy Ventures
151	Blue Water Life Science Fund
152	BlueRun Ventures
153	Blumberg Capital
154	BOCGI Zheshang Capital
155	Boehringer Ingelheim
156	Boehringer Ingelheim Venture Fund
157	Bold Capital Partners
158	BootstrapLabs
159	Boston Angel Club
160	Boston Millennia Partners

161	Boundary Capital Partners LLP
162	Boxer Capital
163	BoxGroup
164	Bpifrance
165	Brightspark Ventures
166	Brinc
167	Bristol Myers Squibb
168	Bristol-Myers Squibb
169	btov Partners
170	Buchanan Investments
171	Builders VC
172	Bulba Ventures
173	Business Finland
174	BVF Partners
175	Caffeinated Capital
176	Calculus Capital
177	California Institute for Regenerative Medicine
178	Cambia Health Solutions
179	Cambridge Angels group
180	Canaan Partners

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

181	Canada Pension Plan Investment Board
182	Cantos
183	Capikris Foundation
184	Capital One Growth Ventures
185	Capricorn Partners
186	CARB-X
187	Carlyle Global Partners
188	Cascade Investment
189	Cascade Seed Fund
190	Casdin Capital
191	Castor Ventures
192	Catalio Capital Management
193	Catapult Ventures
194	Cathay Innovation
195	Cathexis Ventures
196	Cavendish Impact Capital
197	Cedars-Sinai Accelerator
198	Celesta Capital
199	Celgene
200	Centene

201	Centre for the Development of Industrial Technology (CDTI)
202	Champion Hill Labs
203	Cherubic Ventures
204	Chiesi Pharmaceuticals
205	China Bridge Capital
206	China Canada Angel Alliance
207	China Equity
208	Cigna Ventures
209	CITIC Industrial Investment Group
210	Citrix Startup Accelerator
211	Citrix Systems
212	City Hill Ventures
213	Civilization Ventures
214	CKA Capital Ltd
215	Claremont Creek Ventures
216	Clarus Ventures
217	CLI Ventures
218	CM-CIC Capital Finance
219	CNO Financial Group
220	Cobre Capital

221	Colorcon
222	Colt Ventures
223	Columbia Capital
224	Commodore Capital
225	Congressionally Directed Medical Research Programs
226	Connecticut Innovations
227	Connectivity Ventures Fund
228	Contour Venture Partners
229	Conversion Ventures LLC
230	Cormorant Asset Management
231	Corvex
232	Cosine
233	Cota Capital
234	Counterpoint Global
235	Cowen Healthcare Investments
236	CPE
237	CPP Investment Board Europe
238	Creative Destruction Lab (CDL)
239	Credit Suisse
240	Crista Galli Ventures

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241	Crosslink Capital
242	Crowdcube
243	CRV
244	CTI Life Sciences Fund
245	Cue Ball
246	Cultivian Sandbox Ventures
247	curative ventures
248	D. E. Shaw Research
249	D1 Capital Partners
250	Dainippon Sumitomo Pharma
251	Daishin Securities
252	Darling Ventures
253	DCM Ventures
254	DCVC
255	DCVC Bio
256	Debiopharm Group
257	Debiopharm Innovation Fund
258	Decacorn Capital
259	Deep Knowledge Ventures
260	Deerfield

261	Deerfield Capital Management
262	Deerfield Management
263	DEFTA Partners
264	Dementia Discovery Fund
265	Density Ventures
266	Dentsu
267	Desjardins-Innovatech
268	Development Bank of Wales
269	Dexcel Pharma
270	DHVC
271	Digital Science
272	DigiTx Partners
273	DNA Capital
274	Dolby Family Ventures
275	Domain Associates
276	Dorm Room Fund
277	Draper Associates
278	Draper Dragon
279	Dreamit Ventures
280	Driehaus Capital Management

281	Drive Capital
282	DROIA
283	dRx Capital
284	DSC Investment
285	DTRIBE Capital
286	Duquesne Family Office
287	Dynamk Capital
288	EASME - EU Executive Agency for SMEs
289	Eastern Bell Capital
290	EBRD (Investment Firm)
291	Echo Health Ventures
292	EcoR1 Capital
293	EDBI
294	Eden Strategy Institute
295	Eight Roads Ventures
296	Eisai
297	Elaia
298	Elev8.VC
299	Eli Lilly
300	Emerald Development Managers

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301	Emerge Education
302	Emerging Technology Partners
303	Endeavour Vision
304	Endure Capital
305	ENISA
306	Entrepreneur First
307	EOS VC Fund
308	EPIC Capital
309	EPIC Ventures
310	Era Funding Administration
311	Esperante Ventures
312	Euclidean Capital
313	Eurazeo
314	European Bank for Reconstruction and Development
315	European Innovation Council
316	European Union
317	Eurostars
318	Eventide Asset Management
319	Evotec
320	F-Prime Capital

321	Fairhaven Capital Partners
322	Familie C (Clarins Family)
323	Farallon Capital Management
324	Federated Kaufmann Fund
325	Felicis Ventures
326	Fidelity
327	Fidelity Canada
328	Fidelity Management and Research Company
329	Fifty Years
330	Financière Boscard
331	FinLab
332	Firlej Kastory
333	First Round Capital
334	First Star Ventures
335	Fiscus Ventures
336	Fitz Gate Ventures
337	Flagship Pioneering
338	Flare Capital Partners
339	Flex Capital
340	Fly Ventures

341	Flybridge
342	Fonds Vives II (University of Louvain, UCL)
343	ForeSite Capital
344	Forestay Capital
345	Formic Ventures
346	Foundation Capital
347	FounderFuel
348	Founders Factory
349	Founders Fund
350	FoundersX Ventures
351	Franklin Templeton
352	Franklin Templeton Investments
353	Frazier Healthcare Partners
354	Front Row Fund
355	Fund+
356	FundersClub
357	Fushia Investments
358	Fusion Fund
359	Future Fund
360	Future Shape

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361	Future Ventures
362	Gaorong Capital
363	Garage Capital
364	GE Ventures
365	Geekdom Fund
366	GEIF Ventures
367	General Atlantic
368	General Catalyst
369	Generation Investment Management
370	Genuity Science
371	Geodesic Capital
372	GGV Capital
373	Gi Global Health Fund LP
374	Gilde Healthcare
375	GL Ventures
376	Glade Brook Capital Partners
377	Global Brain Corporation
378	Global Founders Capital
379	GM&C Life Sciences Fund
380	GNI Group

381	Golden Seeds
382	Golden Ventures
383	Goldman Sachs Asset Management
384	Good Growth Capital
385	Goodman Capital
386	Google
387	Government Of Quebec
388	GPG Ventures
389	Gradient Ventures
390	Grand Central Tech
391	Grand Challenges Canada
392	Grape Arbor VC
393	Great Oaks Venture Capital
394	Greater Bay Area Homeland Development Fund
395	Green Park & Golf Ventures
396	GreenSky Capital
397	Greenspring Associates
398	Grey Sky Venture Partners
399	Greycroft
400	Greylock

401	GRIDS Capital
402	Groupe Pasteur Mutualité
403	Grove Ventures
404	GSR Ventures
405	GT Healthcare Capital Partners
406	Guardian Life
407	Guardian Life Insurance Company - Dental Service Organization
408	GV
409	Hacking Health Accelerator
410	Hanghai Studio
411	HarbourVest Partners
412	Harmonix
413	Harpoon
414	HAX
415	HBM Healthcare Investments AG
416	HBM Partners
417	Health Ventures
418	HealthInc
419	Healthware Ventures
420	Hemex

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421	Hemi Ventures
422	Heritage Provider Network
423	Hewlett Packard Pathfinder
424	Highland Capital Partners
425	HIGHLINEvc
426	Hike Ventures
427	Hikma Ventures
428	Hillhouse Capital Group
429	Hitachi Ventures
430	Hiventures
431	HOF Capital
432	Holnest
433	Holtzbrinck Digital
434	Honeywell Venture Capital
435	Hongyou Investment
436	Horizon 2020
437	Horizon Healthcare Services
438	Horizons Ventures
439	Hoxton Ventures
440	Human Capital

441	Hunza Ventures
442	Hyperplane Venture Capital
443	IA Ventures
444	iCarbonX
445	ICF Capital
446	Icon Ventures
447	ICONIQ Growth
448	IDG Capital
449	Idinvest Partners
450	iGan Partners
451	Illumina
452	Illumina Ventures
453	Imagen Capital Partners
454	Imperial Create Lab
455	Inbio Ventures
456	Indaco Venture Partners
457	Index Ventures
458	IndieBio
459	Industry Ventures
460	Infinity Medical

461	INGENIUM Emilia Romagna
462	Initialized Capital
463	Innospark Ventures
464	Innovate UK
465	Innovation Endeavors
466	Innovatus Capital Partners
467	Inovia Capital
468	Institut Català de Finances (ICF Capital)
469	Intel Capital
470	Intermountain Healthcare
471	Intermountain Ventures
472	International Private Bank (IPB)
473	InterVest Co.
474	Inventures
475	Invoke Capital Partners
476	Invus
477	IQ Capital
478	Isomer Capital
479	IvyCap Ventures
480	J. Hunt Holdings

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481	Janssen Belgium
482	Janus Henderson Investors
483	Jazz Venture Partners
484	Jianke
485	Jiantou Huawei Investment
486	Johnson & Johnson Innovation
487	Johnson & Johnson Innovation – JJDC
488	JSR Corp
489	Juvenescence
490	K9 Ventures
491	Kaiser Foundation Hospitals
492	Kaiser Permanente
493	Kakao Ventures
494	Kapor Capital
495	Karlin Ventures
496	KB Securities
497	KDB Bank
498	KDB Capital
499	KdT Ventures
500	Keiretsu Forum

501	Kepha Partners
502	Khosla Ventures
503	Kima Ventures
504	Kindred Capital
505	Kleiner Perkins
506	Knoll Capital Management
507	Koch Disruptive Technologies
508	Krohne
509	KTB Network
510	La Famiglia
511	LabCorp
512	Lake Bleu Capital
513	Lakestar
514	Launch Lane
515	LaunchCapital
516	Laurion Capital Management
517	LB Investment
518	LBO France
519	LDV Partners
520	Leaps by Bayer

521	Legend Capital
522	Life Sciences Angel Network
523	Life Sciences Partners
524	Life Sciences Research Partners V.Z.W.
525	Lifeforce Capital
526	LifeSci Venture Partners
527	Lightspeed China Partners
528	Lightspeed Venture Partners
529	Lightstone Ventures
530	Lilly Asia Ventures
531	Lilly Ventures
532	Linden Mobile Ventures
533	Linear Capital Partners
534	Linear Venture
535	Liquid 2 Ventures
536	Litmore Capital
537	Logos Capital
538	London Co-Investment Fund
539	Long Hill Capital
540	Longevity Vision Fund

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541	Longley Capital
542	Loup Ventures
543	Lucas Venture Group
544	Luminous Ventures
545	Lux Capital
546	LVL1 Group
547	M12
548	Mack-Cali Realty Corporation
549	MACSF
550	Madrona Venture Group
551	Madryn Asset Management
552	Magnetic Ventures
553	Maison Capital
554	Manchester Tech Trust Angels
555	Marathon Venture Capital
556	Marketplace Funds
557	MaRS Discovery District
558	Marshall Wace
559	Masa Life Science Fund
560	MassChallenge

561	MassMutual Ventures Southeast Asia (MMV SEA)
562	Matrix Capital Management
563	Matrix Partners
564	Maverick Ventures
565	Mayo Clinic Ventures
566	McKesson Ventures
567	MedTech Innovator
568	Menlo Ventures
569	Merck
570	Merck Global Health Innovation Fund
571	Mercury Fund
572	Meridian Street Capital
573	Mérieux Equity Partners
574	Metaplanet Holdings
575	Michael J. Fox Foundation
576	Microsoft
577	MidCap Financial
578	Midven
579	Mighty Capital
580	Millennium Management

581	Millennium Technology Value Partners
582	Mirae Asset Capital
583	Mirae Asset Venture Investment
584	Mission and Market
585	Mission Bay Capital
586	Mission BioCapital
587	MIT delta v
588	MITS Fund
589	Mitsui & Co
590	Monashee Investment Management
591	Moneta VC
592	Monsanto Growth Ventures (MGV)
593	Morgan Noble
594	Mossrock Capital
595	MPM Capital
596	MRL Ventures Fund
597	MS&AD Ventures
598	MSA Capital
599	MTIP AG
600	Mubadala

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601	Mubadala Capital Ventures Europe
602	Mubadala Capital Ventures US
603	Mubadala Capital Ventures
604	MVM Life Science Partners
605	Nan Fung Life Sciences
606	National Heart, Lung and Blood Institute
607	National Human Genome Research Institute
608	National Institute of Neurological Disorders and Stroke
609	National Institutes of Health
610	National Science Foundation
611	NEC Solution Innovators
612	Neo
613	Neoteny
614	Neptune Investment Management
615	Nest.Bio Ventures
616	Nesta Ventures
617	Neue Fund
618	New Enterprise Associates
619	New Leaf Venture Partners
620	New York State

621	New York Ventures
622	Newable Ventures
623	Newchip
624	NewDo Venture
625	Newpath Management
626	Nex Cubed
627	Nex Cubed Digital Health
628	NEXT Canada
629	Next Play Capital
630	NextAI
631	Nextech Invest
632	NextFab
633	NIF Ventures
634	Nikon
635	Nimble Ventures
636	Nina Capital
637	NJF Capital
638	Nordic Impact
639	North Sound Ventures
640	Northleaf Capital Partners

641	Northpond Ventures
642	Northstar Ventures
643	Novaquest Capital Management
644	Novartis
645	Novartis Institutes
646	Novartis Pharma
647	Novartis Venture Fund
648	Novatio Ventures
649	Novo Holdings
650	NPIF Maven Equity Finance
651	NTT Venture Capital
652	NTTVC
653	Nvidia Inception
654	O2h Ventures
655	Oak HC/FT
656	Obvious Ventures
657	OCA Ventures
658	Octopus Ventures
659	Olive Tree Capital
660	Omega Funds

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661	OMX Ventures
662	Ontario Centres of Excellence
663	Open Field Capital
664	Openspace Ventures
665	OrbiMed
666	Organization Name
667	Origin Capital
668	OS Fund
669	Oséo
670	Otium Capital
671	Otsuka Pharmaceutical
672	OTV
673	OUP (Osage University Partners)
674	Outsized Ventures
675	Oxeon Partners
676	Oxford Sciences Innovation
677	Pacific Health Ventures
678	Palantir Technologies
679	Palisades Growth Capital
680	Panache Ventures

681	Parinvest
682	Partech
683	Partner Fund Management
684	Partnership Fund for New York City
685	Patient Square Capital
686	Pavilion Capital
687	Paxion Capital Partners
688	Pear VC
689	Pentech Ventures
690	Perceptive Advisors
691	Perivoli Innovations
692	Perot Jain
693	Pfizer
694	Pfizer Venture Investments
695	PHC Holdings
696	Pi Campus
697	Pictet Private Equity Investors S.A.
698	Piedmont Capital
699	Pillar VC
700	Ping An Ventures

701	Pioneer Fund
702	Pitch@Palace
703	Pivotal bioVenture Partners
704	PivotNorth Capital
705	Plug and Play Tech Center
706	Point Sur Investors
707	Point72 Ventures
708	Polaris Partners
709	Portland Seed Fund
710	PPD
711	Prairie Ventures
712	Prefix Capital
713	Premier Partners
714	President International Development Corporation
715	Princeton Alumni Angels
716	Pritzker Group Venture Capital
717	Pritzker/Vlock Family Office
718	Private Capital Advisors
719	Propagator Ventures
720	Propel(X)

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721	ProQuest Investments
722	PSP Investments
723	Qiming Venture Partners
724	Qualgro VC
725	Quest Diagnostics
726	QVentures
727	QVT Financial
728	R42 Group
729	RA Capital Management
730	Radical Ventures
731	Ramen Ventures
732	Razor's Edge Ventures
733	re.Mind Capital
734	Real Ventures
735	Redalpine
736	Redmile Group
737	Redpoint
738	Refactor Capital
739	Reference Capital (formerly Genevest)
740	Regeneron

741	Reimagined Ventures
742	Reneo Capital Management
743	Rev1 Ventures
744	Revelation Partners
745	Revo Capital
746	Revolution
747	Revolution Growth
748	Revolution's Rise of the Rest Seed Fund
749	Rho Canada Ventures
750	Rho Ventures
751	Ridgeback Capital
752	Right Side Capital Management
753	Rivas Capital
754	Robin Hood Ventures
755	Roca X
756	Roche
757	Roche Venture Fund
758	Rock Springs Capital
759	Rockies Venture Club
760	Rockies Venture Fund

761	Romulus Capital
762	Rough Draft Ventures
763	RT Ventures
764	RTAventures VC
765	RTW Investments LLC
766	Ruvento
767	S.R.I.W.
768	Sage Partners
769	Samsara BioCapital
770	Samsung Ventures
771	Sanabil
772	Sandbox Industries
773	Sanofi
774	Sanofi Ventures
775	Sapphire
776	Sapphire Ventures
777	SCALE AI
778	Scale Venture Partners
779	Schooner Capital
780	Schrödinger

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781	Schusterman Foundation
782	SciFi VC
783	SCOR Life & Health Ventures
784	Scottish Mortgage Investment Trust
785	Sea Lane Ventures
786	Section 32
787	Selvedge Venture
788	Seneca Partners
789	Sequoia Capital
790	Sequoia Capital China
791	Sequoia Capital India
792	Seraph Group
793	Serena
794	Serra Ventures
795	Service Provider Capital
796	ServiceNow
797	Seven Peaks Ventures
798	SFEM Italia
799	SFPI-FPIM
800	SGInnovate

801	Shangbay Capital
802	Shasta Ventures
803	Shengding Equity Investment Fund
804	Shunwei Capital
805	Sierra Ventures
806	SIG China (SIG Asia Investments)
807	Sigma Prime Ventures
808	Silicon Badia
809	Silicon Valley Bank
810	Silicon Valley Ventures
811	Silver Lake Waterman
812	Singtel Innov8
813	Sinovation Ventures
814	Sixty Degree Capital
815	SK Holdings
816	SKS PE
817	Sky Ventures Group
818	Slow Ventures
819	Small Business Innovation Research
820	Smedvig Capital

821	Snowflake Ventures
822	Social Capital
823	Social Impact Capital
824	Sofinnova Partners
825	SoftBank
826	SoftBank Group
827	Softbank Ventures Asia
828	SoftBank Vision Fund
829	SoGal Ventures
830	Soleus Capital
831	Soma Capital
832	SOSV
833	Sound Ventures
834	South Park Commons
835	SPARK Impact
836	SpesNet Pte. Ltd.
837	SpringRock Ventures
838	Square 1 Bank
839	SR One
840	Stage Venture Partners

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

841	Stanford Angels and Entrepreneurs
842	Starlight Ventures
843	Start Capital
844	Startup Capital Ventures
845	StartUp Health
846	StartX (Stanford-StartX Fund)
847	Sto-Rahoitus
848	Strategic Investors (Board & Advisors)
849	Streamlined Ventures
850	Stripes
851	Summit Partners
852	Sunfish Partners
853	Surveyor Capital
854	Susa Ventures
855	Sustainable Conversion Ventures
856	Suvretta Capital Management
857	SV Angel
858	SV Tech Ventures
859	Sway Ventures
860	Swisscom Ventures

861	SyndicateRoom
862	Synetro Group
863	Synthetic Genomics
864	System One
865	T. Rowe Price
866	Tachyon Ventures
867	Taikang Asset
868	Taikang Life Insurance
869	Taiwan Tech Arena
870	Talos VC
871	Tamarind Hill
872	Tanarra Credit Partners
873	Tavistock Group
874	TCP Venture Capital
875	TD Veon
876	Teal Ventures
877	Team Builder Ventures
878	Tech Coast Angels
879	Tech Transfer UPV
880	Techammer

881	Techstars
882	Techstars Montreal AI Accelerator
883	TechU Ventures
884	Temasek Holdings
885	Temple University
886	Tencent
887	TenOneTen Ventures
888	Tensor Ventures
889	Terra Magnum Capital Partners ("TMCP")
890	The Baupost Group
891	The Chartered Group
892	The Column Group
893	The Family
894	The Index Project
895	The Longevity Fund
896	The North West Fund
897	The Scripps Research Institute
898	The Syndicate Group
899	The Thiel Foundation
900	The University of Texas System

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901	Third Kind Venture Capital
902	Third Rock Ventures
903	Threshold
904	TIA Ventures
905	TiE Angels
906	Tiger Global Management
907	Time Warner Investments
908	Tiny Super Computer Investment Company
909	TLV Partners
910	Topspin Partners
911	Touchdown Ventures
912	TPG
913	TPG Biotech
914	Trancos Ventures
915	Transformation Capital
916	Transformational Healthcare Opportunity
917	Trend Investment Group
918	Tribeca Venture Partners
919	Trinitas Capital
920	True Ventures

921	Truffle Capital
922	TSVC
923	TT Capital Partners
924	Tudor Growth Equity
925	Tuesday Capital
926	TVM Capital
927	Twin Capital Management LLC
928	Two River
929	Two Sigma Ventures
930	Two Small Fish Ventures
931	uBiome
932	UCB
933	UK Innovation & Science Seed Fund
934	UL Ventures
935	Ulu Ventures
936	Uncommon Denominator
937	Uncork Capital
938	Uni-Innovate Group
939	Universal Materials Incubator
940	University of Birmingham

941	University of Delaware
942	University of Minnesota
943	Unshackled Ventures
944	UpHonest Capital
945	UPMC
946	Upscale
947	Upside Partnership
948	UTEC - The University of Tokyo Edge Capital Partners
949	UV-Cap
950	Validus Growth Investors
951	Valor Ventures
952	Vanedge Capital
953	Varian
954	Vectr
955	Velocity.Partners
956	venBio Partners
957	Venrock
958	Verily
959	Vertex Ventures
960	Vertex Ventures HC

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

961	Vertex Ventures Israel
962	Vertex Ventures Southeast Asia & India
963	Verve Ventures
964	Viking Global Investors
965	Village Global
966	Vinno Capital
967	Viola Group
968	Visium Healthcare Partners
969	VisVires New Protein
970	Viva BioInnovator
971	Viva Biotech
972	Vives Louvain Technology Fund
973	Vivo Capital
974	Voxel Ventures
975	Walden Riverwood Ventures
976	Walking Ventures
977	Warburg Pincus
978	Washington Research Foundation
979	Waycross Ventures
980	Wellington Management

981	Western Digital Capital
982	Western Technology Investment
983	Westlake Village BioPartners
984	Westwood Ventures
985	WI Harper Group
986	Wild Basin Investments
987	WONIK Investment Partners
988	WorldQuant Ventures LLC
989	Wren Capital
990	WuXi AppTec
991	WuXi Healthcare Ventures
992	Y Combinator
993	Yahui Investment
994	Yitu Technology
995	ZhenFund
996	Zhongyuan Union Cell & Gene Eng
997	Ziff Capital Partners
998	Zola Global Investors
999	ZS Associates

36 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. Daewoong Pharmaceuticar	United States	daewoong.com
8. DEXA Medica Group	Asia	dexa-medica.com
9. Eddingpharm (Cayman)	Asia	eddingpharm.com
10. Eli Lilly	United States	lilly.com/
11. Galapagos NV	United States	glpg.com
12. Genentech	United States	gene.com
13. Gilead Sciences Inc.	United States	gilead.com
14. GSK	United States	gsk.com
15. Hanmi Pharmaceutical	Asia	hanmnipharm.com
16. Illumina	United States	illumina.com
17. Jamjoom Pharma	Asia	jamjoompharma.com
18. Janssen Pharmaceuticals	European Union	janssen.com

36 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
19. Johnson & Johnson	United States	jnj.com
20. La jolla Pharmaceutical	United States	janssen.com
21. Maruishi Pharmaceutical Co. Ltd.	Asia	maruishi-pharm.com
22. Merck	United States	merck.com
23. Mitsubishi Tanabe Pharma	Asia	mt-pharma.co.jp
24. Nektar Therapeutics	European Union	nektar.com
25. Novartis	European Union	novartis.com
26. Novo Nordisk	European Union	novonordisk.com
27. Otsuka Pharmaceutical	Asia	otsuka.com
28. Pfizer	United States	pfizer.com
29. Roche	European Union	roche.com
30. Sanofi	European Union	sanofi.com
31. Santen	United States	santen.com
32. Shionogi	Asia	shionogi.co.jp
33. Sumitomo Dainippon Pharma	Asia	ds-pharma.com
34. Takeda	Asia	shire.co.jp
35. Teva Pharmaceutical	Asia	tevapharm.com
36. Viva BioInnovator	Asia	vivabioinnovator.com

31 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
16. Huawei	United States	huawei.com

31 Tech Corporations Applying Advanced AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
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.com/en-in
22. Oracle	United States	oracle.com
23. Pulse Inframe	Canada	pulseinframe.com
24. RAIR Health	United Kingdom	rair.ai
25. Salesforce	United States	salesforce.com
26. Samsung Electronics	United States	samsung.com/us
27. SAP	Asia	sap.com
28. Siemens	European Union	siemens.com
29. Tencent	European Union	tencent.com/en-us
30. Unisys	China	unisys.com
31. Workday	United States	workday.com

20 CROs AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
1. Actimus Biosciences	Asia	actimusbio.com
2. Aptuit	European Union	aptuit.com
3. BioClinica	United States	bioclinica.com
4. Charles River Laboratories	United States	criver.com
5. CMIC	Asia	en.cmicgroup.com
6. Covance	United States	covance.com
7. Evotec	European Union	evotec.com
8. Frontage Holdings	United States	.frontagelab.com
9. ICON	United States	iconbuild.com
10. IonsGate	Canada	ionsgate.com
11. IQVIA	United States	iqvia.com
12. Iris Pharma	European Union	iris-pharma.com
13. J-STAR Research, Inc. / Porton	United States	jstar-research.com
14. Open Orphan plc	European Union	openorphan.com
15. PAREXEL	United States	parexel.com
16. Phastar	United Kingdom	phastar.com
17. Phlexglobal	United Kingdom	phlexglobal.com
18. PRA International	United States	prainternational.com
19. Samsung Biologics	Asia	samsungbiologics.com
20. SGS	European Union	sgs.com

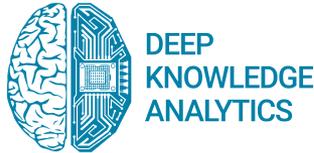
15 Chemical Corporations Applying AI in Healthcare

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 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:



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 biotech, 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.

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.

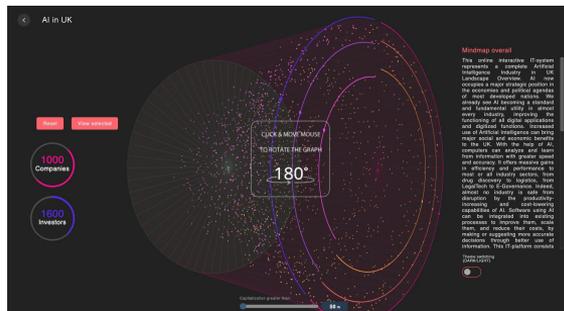
Our reports are supported by our rapidly developing data mining engine, data visualization platform and analytics dashboards.

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

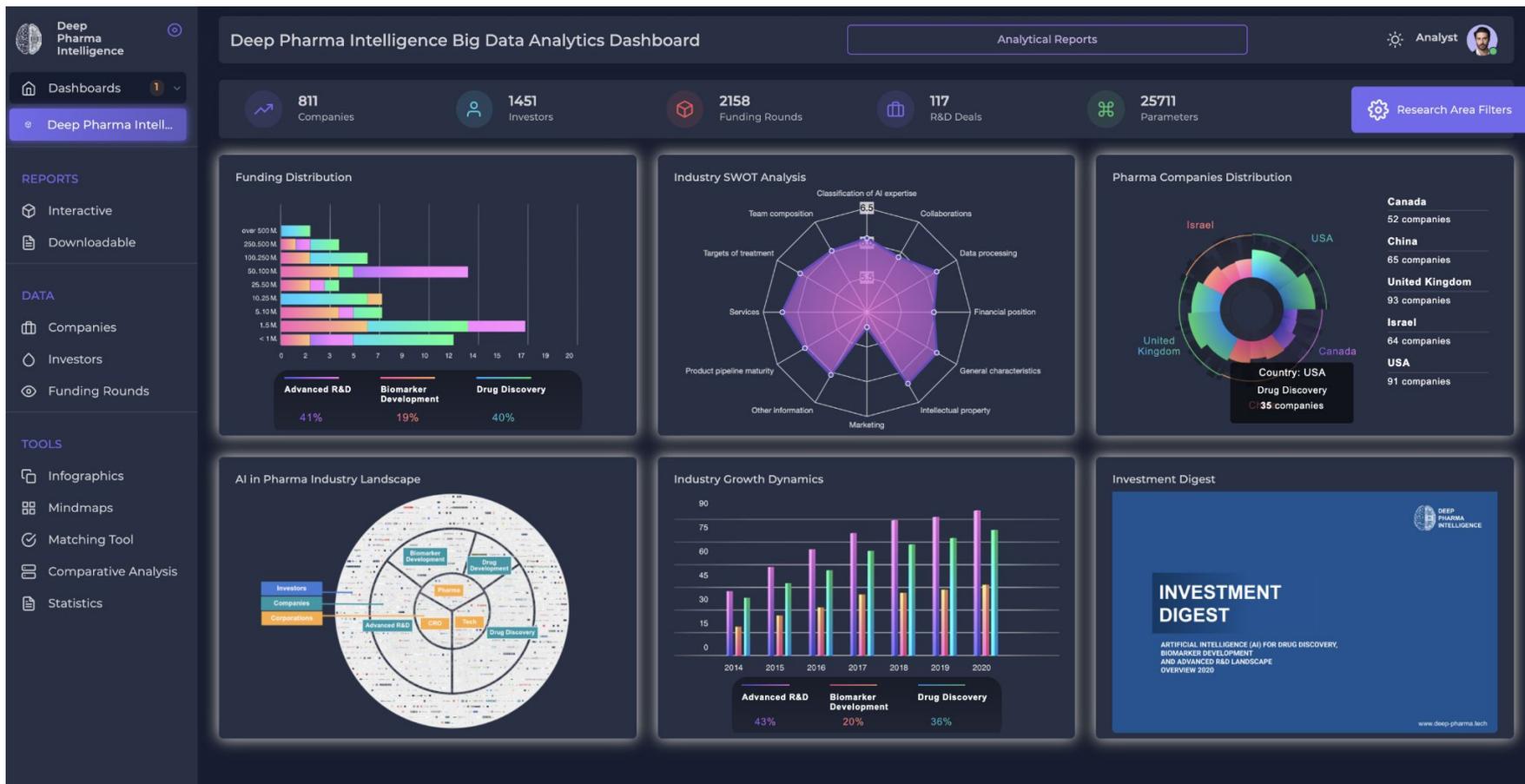
Deep Pharma Intelligence Big Data Analytics Dashboard

Landscape Analytics	Deep Pharma Industry Landscape	General Developments	Most Innovative R&D Approaches	Other Assessments
	View More	View More	View More	View More
Industry Developments	General Findings	Industry Developments	Proprietary Analytics	Landscape Overview 2020
	View More	View More	View More	View More



[Visit Our Deep Pharma Intelligence Big Data Analytics Dashboard platform.dkv.global/dashboards/ai-for-drug-discovery/](http://platform.dkv.global/dashboards/ai-for-drug-discovery/)

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A2A Pharmaceuticals is a biotechnology company committed to the advancement of innovative scientific research and new therapeutic agents.

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AcuraStem harnesses human, patient-specific in vitro cell models and assays to develop cures and improve diagnoses in disorders of the CNS.

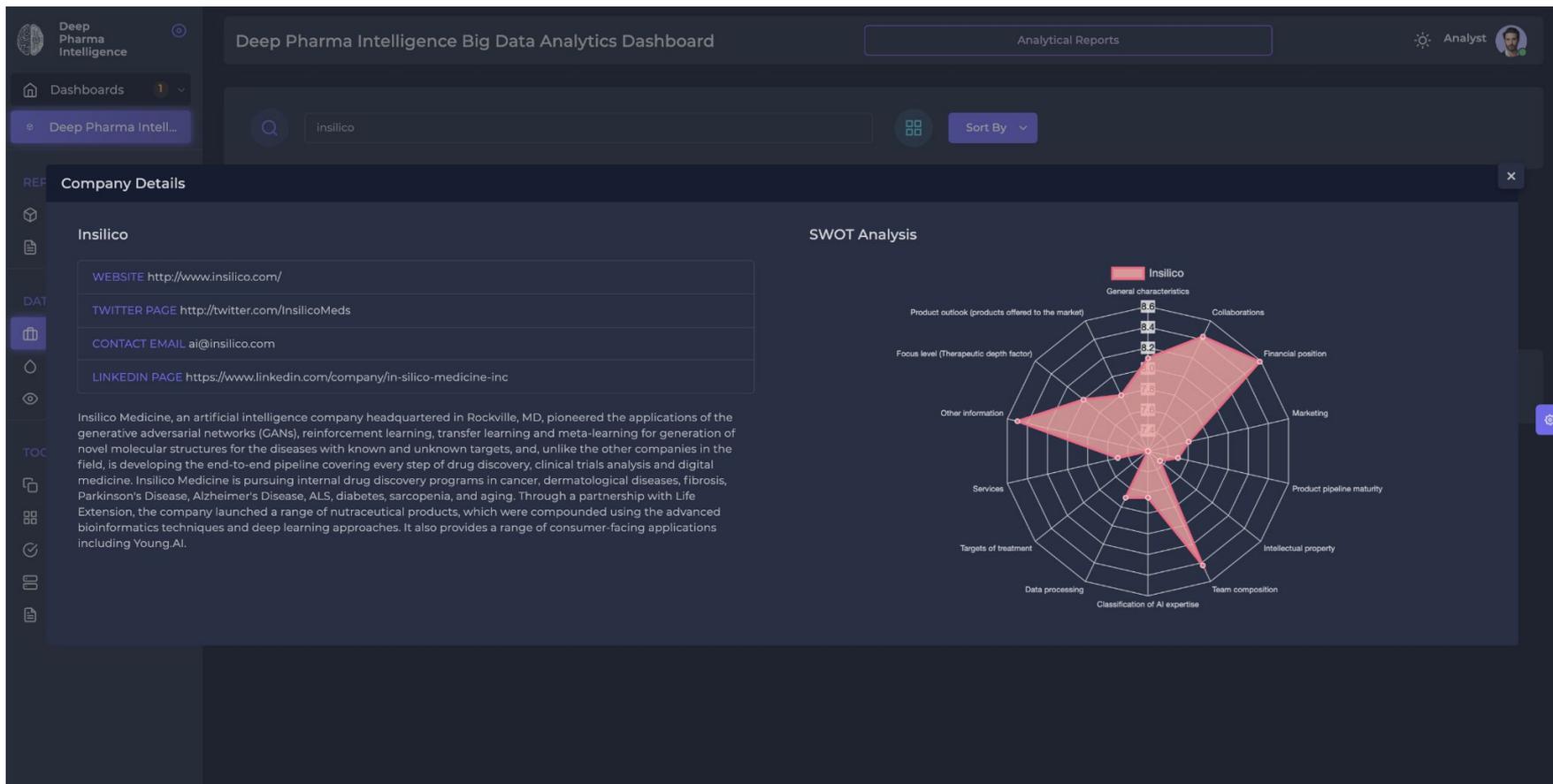
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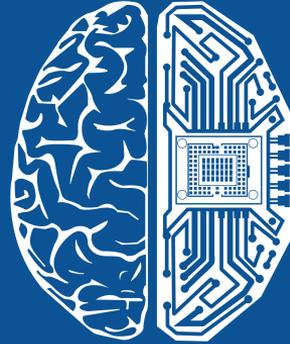
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Deep Pharma Intelligence: Analytical Dashboard





[Link to the Report: deep-pharma.tech/landscape-overview-q2-2021](https://deep-pharma.tech/landscape-overview-q2-2021)

E-mail: info@deep-pharma.tech

Website: deep-pharma.tech

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