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AI in Pharma
Investment Digest Q1 2024

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Introduction

This 115-page **"Artificial Intelligence in Pharma. Investment Digest 2023"** report represents the eleventh issue of market analytics focused on the Artificial Intelligence (AI) application in the pharmaceutical research industry.

The primary goal of this series of reports is to give a complete picture of the industry environment in terms of AI usage in drug discovery, clinical research, and other elements of pharmaceutical research and development. This overview highlights recent trends and insights in the form of helpful mind maps and infographics and gauges the performance of prominent players who shape the industry's space and relationships. It can help the reader comprehend what is going on in the sector and potentially predict what will happen next.

Since the last edition, data has been significantly updated to reflect the fast-paced market dynamics and an overall increase in pharmaceutical AI investment and business development activities. The listings of AI-biotech businesses, biotech investors, and pharmaceutical organizations have been expanded to reflect the pharmaceutical industry's rising interest in sophisticated data analytics technology.

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

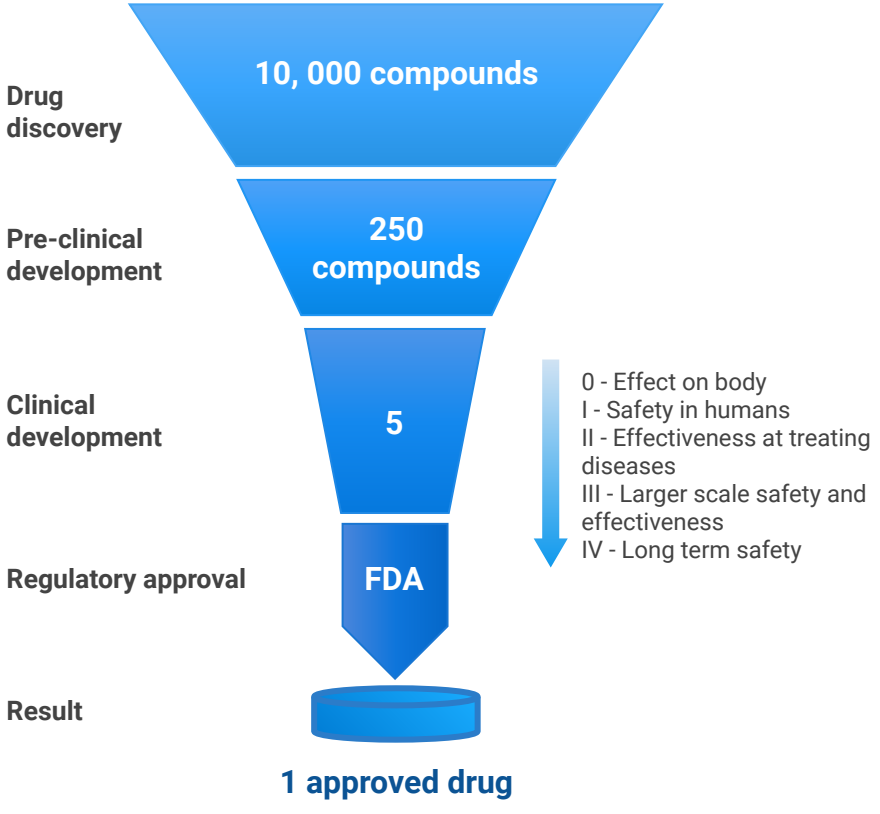
AI In Pharma Sector at a Glance

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 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.)

AI in Pharma sector stands out as one of the most rapidly growing and conceptually important. Summarizing industry observations over the last five years, we can observe a fundamental shift in the perception by top executives at leading pharmaceutical organizations about the need for advanced AI technologies. Since 2015, there has been an obvious perception shift from skepticism and cautious interest, to a realization of the strategic role AI has to play in the emerging “data-centric” model of innovation.



Introduction to AI in Drug Development

Artificial Intelligence in Drug Discovery Analytical Framework

Focus on Applications of AI for Drug Discovery

- Advanced R&D
- Biomarkers Development
- Drug Discovery

Focus on Applications of AI for Oncology Diagnostics and Treatment

- AI-Assisted Diagnostics
- At-Home Cancer Detection With AI-Based Devices
- Clinical Decision Support
- Medical Images Analysis
- Patients Outcome Prediction
- Personalized Treatment Options Identification

Established Drug Discovery-Oriented Entities

Early Drug Development

- Compounds Classification
- Drug Repurposing
- Identifying New Drug Candidates
- Identifying New Drug Pathways
- Identifying New Drug Structures
- Hit Identification
- Lead Optimization
- Predictive Drug Modeling
- Target Identification
- Virtual Screening

Clinical Drug Development

- Identifying Drug to Drug Interactions
- Identifying New Drug Indications
- Identifying New Metabolic Pathways
- Identifying Suitable Patients
- Imaging Analysis
- Patient Stratification
- Predictive Modeling
- Real-Time Monitoring

End-to-End Drug Development

- Automated End-to-End Drug Analysis
- Automated End-to-End Drug Production
- Predictive Patient Reaction Modeling
- Virtual Experiment Processing

Preclinical Development and Automation

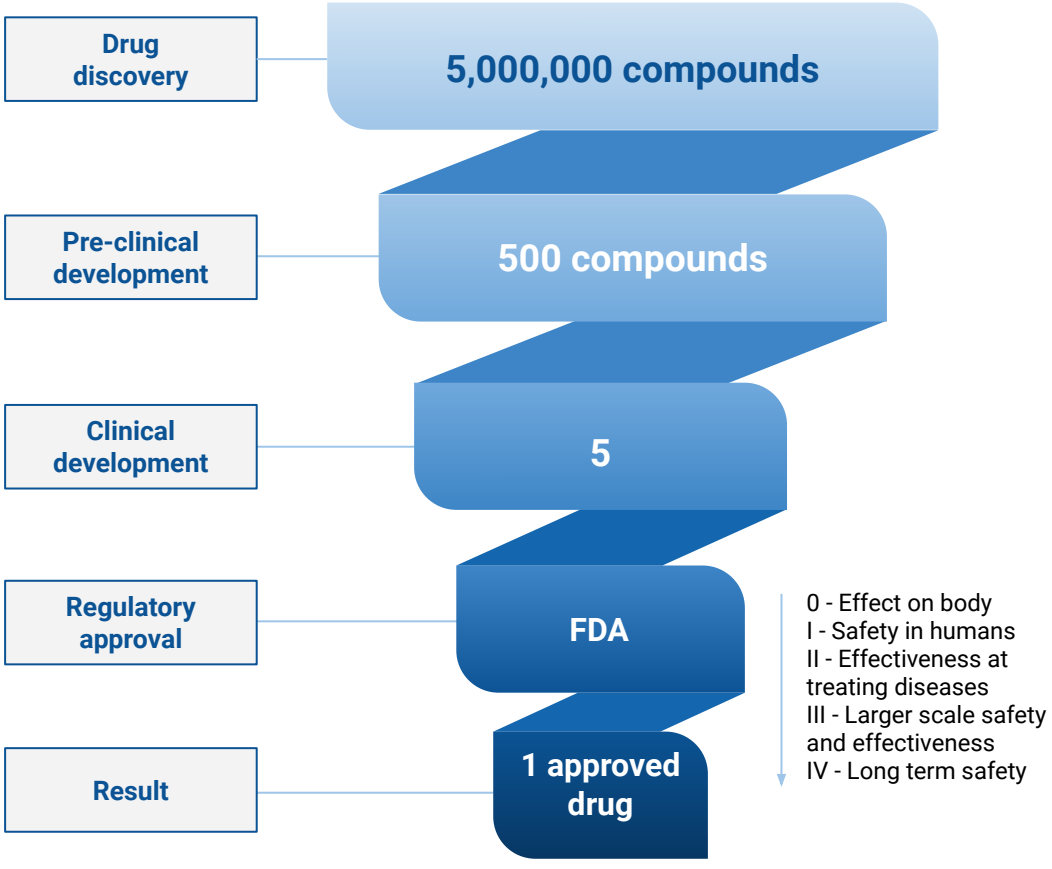
- ADME/PK Modeling
- Experiment Data Analyzing
- Preclinical Protocol Optimization
- Robotic Hands
- High Throughput Screening
- Drug Safety Improving
- Preclinical Trials Prediction
- Preclinical Imaging Analysis
- Robotic Laboratories
- Collaborative Robots

Data Processing

- Chemical Data Analyzing
- Clinical Trials Data Analyzing
- Imaging Data Analysis
- Lab Experiments Data Analyzing

Source: ***www.frameworks.technology/ai-in-drug-discovery***

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 a 145% increase, correcting for inflation, compared to the same report made in 2003.

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

The solution to this problem comes from three key strategies:

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

Source: *Conflict of Interest in Medical Research, Education, and Practice*, *medinicenet.com*

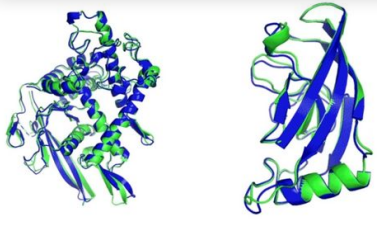
Notable Breakthroughs in AI for Pharma

2019

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

2020

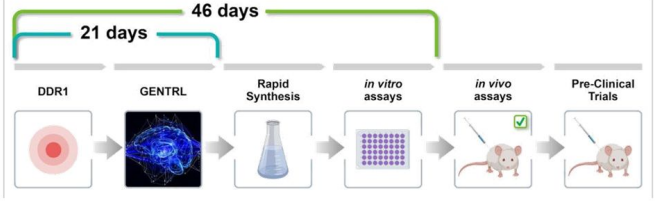
DeepMind's AlphaFold learns to predict protein's 3D shape from its amino-acid sequence, a 50 year-old grand challenge in biology.



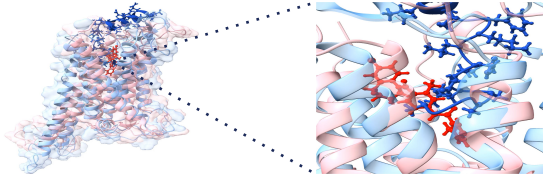
Experimental Result
Computational Prediction

2021

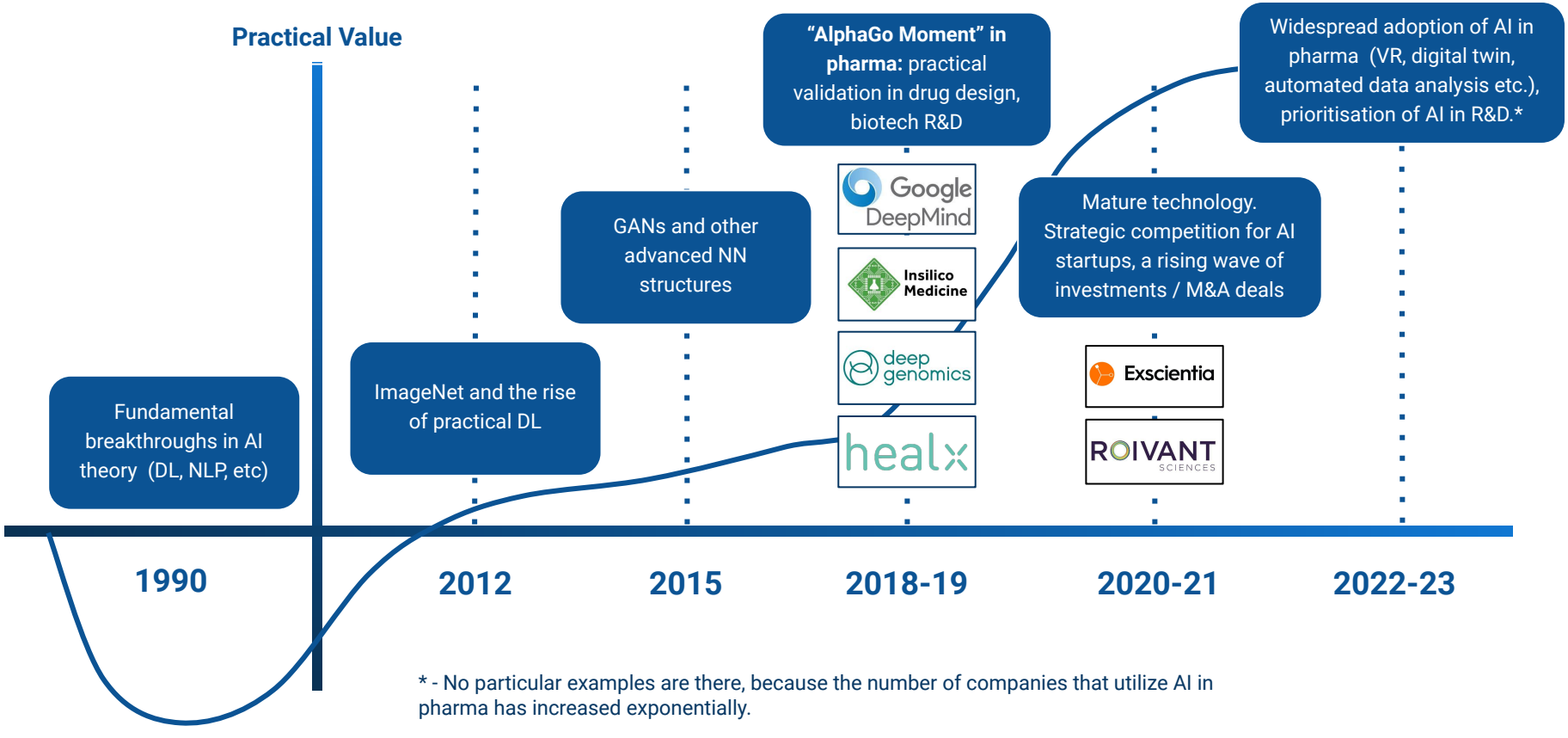
Insilico Medicine applied generative adversarial network-based system GENTRL for rapid identification of potent DDR1 Kinase inhibitors within 21 days.



Peptilogics developed generative AI to predict peptides that bind to arbitrary proteins, even given only a protein's primary sequence, unlocking peptide drug design for established and novel targets.



Pharma's “AlphaGo Moment”



* - No particular examples are there, because the number of companies that utilize AI in pharma has increased exponentially.

Technological Advancements Defining the Market

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 **ISM001-055** demonstrated activity with nanomolar (nM) IC50 values.

2023

Insilico Medicine 英科智能

Preclinical candidate Selected (PCC)

Insilico → Traditional Approach

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

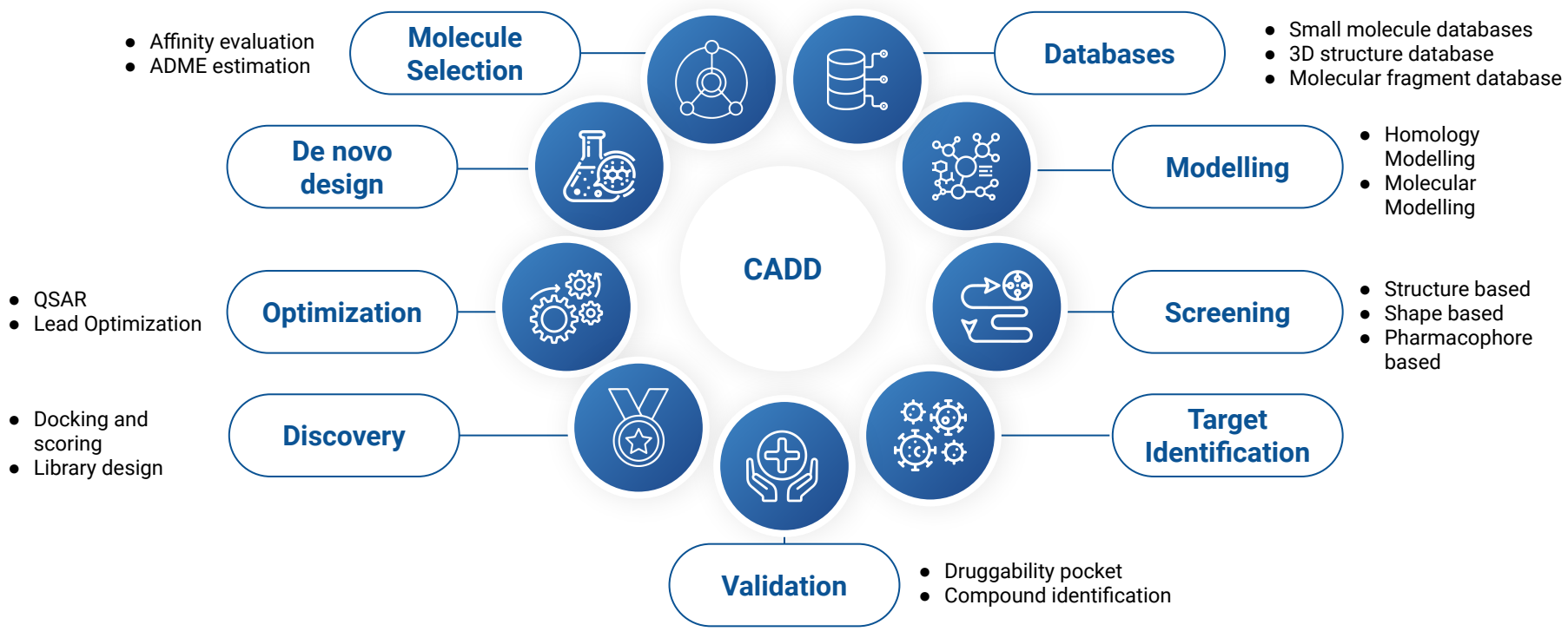
Phase 1 → Phase 2 → Phase 3 → Submission to launch

By this time **ISM001-055** (INS018_055) enters **Phase II** trials both in USA and China. The inhalation solution ISM001-055 showed high tolerance and effective anti-fibrotic and anti-inflammatory properties, as it was predicted in the preclinical studies. It also exhibited favorable safety and pharmacokinetic profiles, with no signs of local or systemic toxicity. Insilico has successfully identified **12** preclinical candidates for its internal drug discovery programs since 2021. Of these, **3** have progressed to human clinical trials.

Source: *Insilico Medicine*

Computer-Aided Drug Design

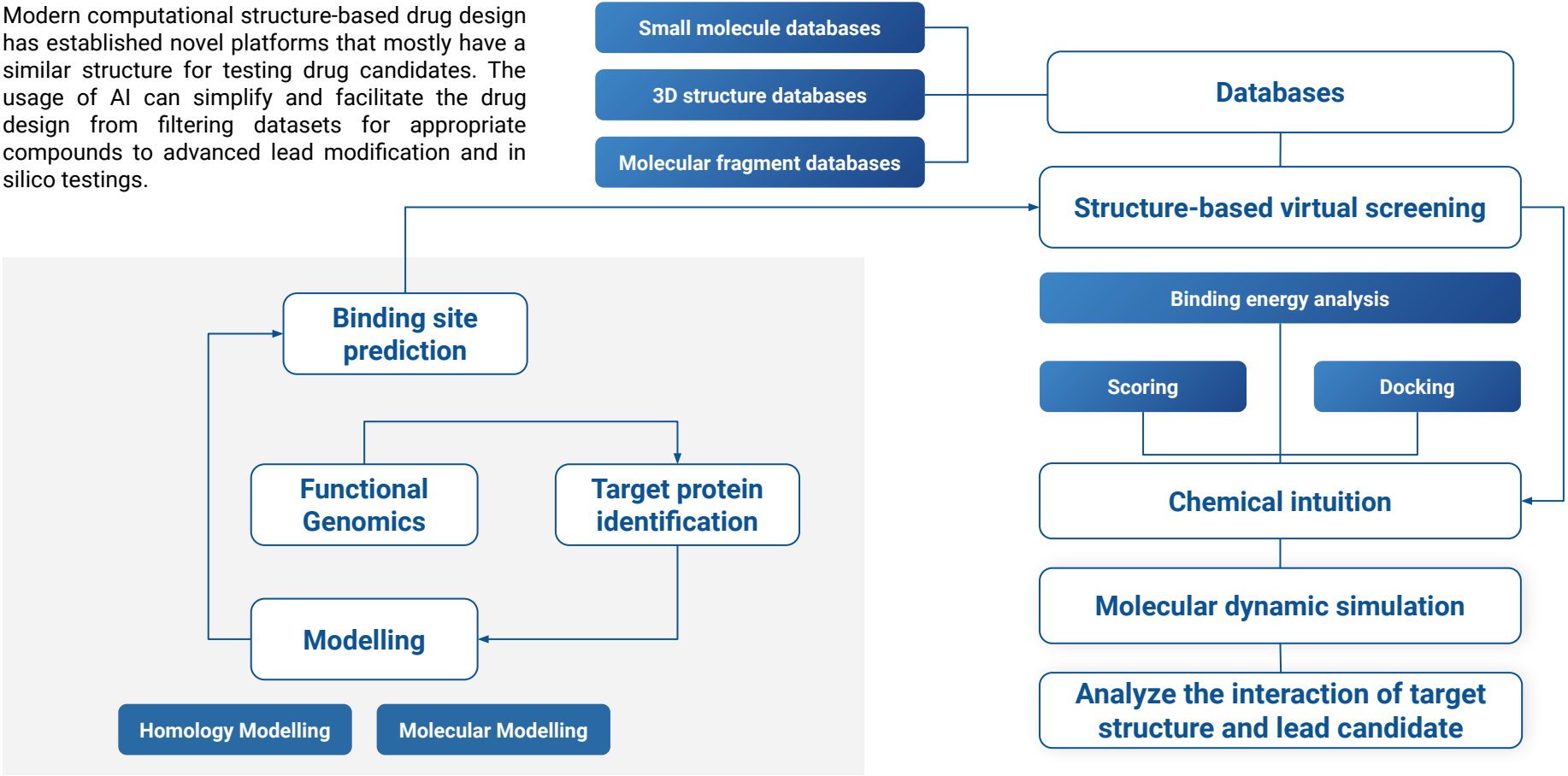
Today's task for the pharma industry is to create a cheap and effective solution for drug development, companies apply various computational methods to reach that goal. **Computer-aided drug design (CADD)** is a modern computational technique used in the drug discovery process to identify and develop a potential lead. CADD includes computational chemistry, molecular modeling, molecular design and rational drug design.



Sources: *Advantages of Structure-Based Drug Design Approaches in Neurological Disorders.*

Computer-Aided Drug Design

Modern computational structure-based drug design has established novel platforms that mostly have a similar structure for testing drug candidates. The usage of AI can simplify and facilitate the drug design from filtering datasets for appropriate compounds to advanced lead modification and in silico testings.



Sources: *Advantages of Structure-Based Drug Design Approaches in Neurological Disorders.*

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

Target Discovery and Early Drug Discovery

Accelerated development of new drugs and targets identification

- Identify novel drug candidates
- Analyze data from patient samples
- Predict pharmacological properties
- Simplify protein design

Clinical Trials

Targeted towards personalized approach and optimal data handling

- Optimize clinical trial study design
- Patient-representative computer models
- Define best personalized treatment
- Analyze medical records
- Improve pathology analysis

Design and Processing of Preclinical Experiments

Optimization of experiments and data processing

- Reduce time and cost of planning
- Decode open- and closed-access data
- Automate selection, manipulation, and analysis of cells
- Automate sample analysis with a robotic cloud laboratory

Aggregation and Synthesis of Information

Time- and resources-efficient information management

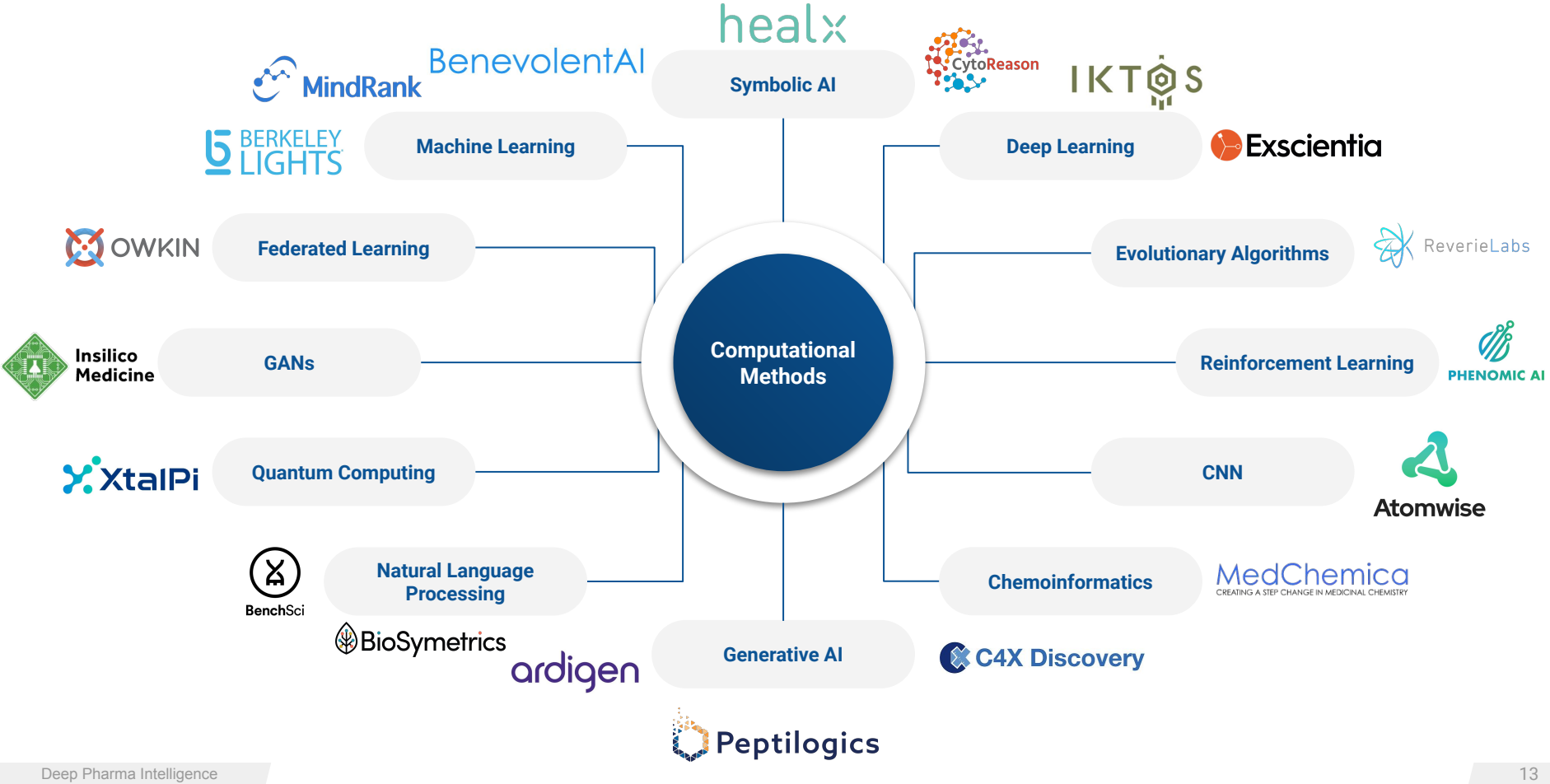
- Generate insights from thousands of unrelated data sources
- Improve decision-making
- Eliminate blind spots in research

Repurposing of Existing Drugs

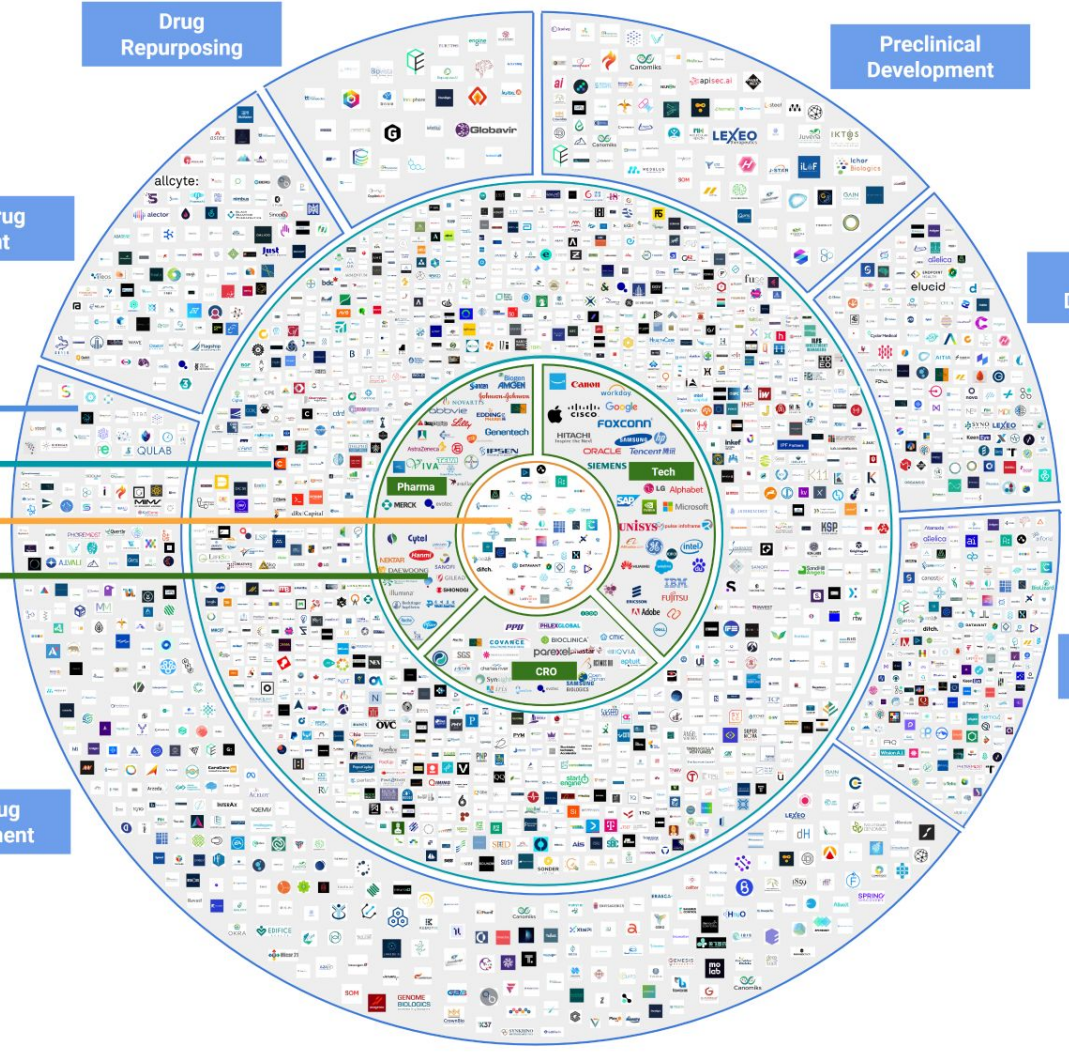
Searching for new applications of existing drugs at a high scale

- Rapidly identify new indications
- Match existing drugs with rare diseases
- Testing 1000+ of compounds in 100+ of cellular disease models in parallel

Computational Methods Used by the Most Advanced AI Companies



Artificial Intelligence in Drug Discovery Q4 2023



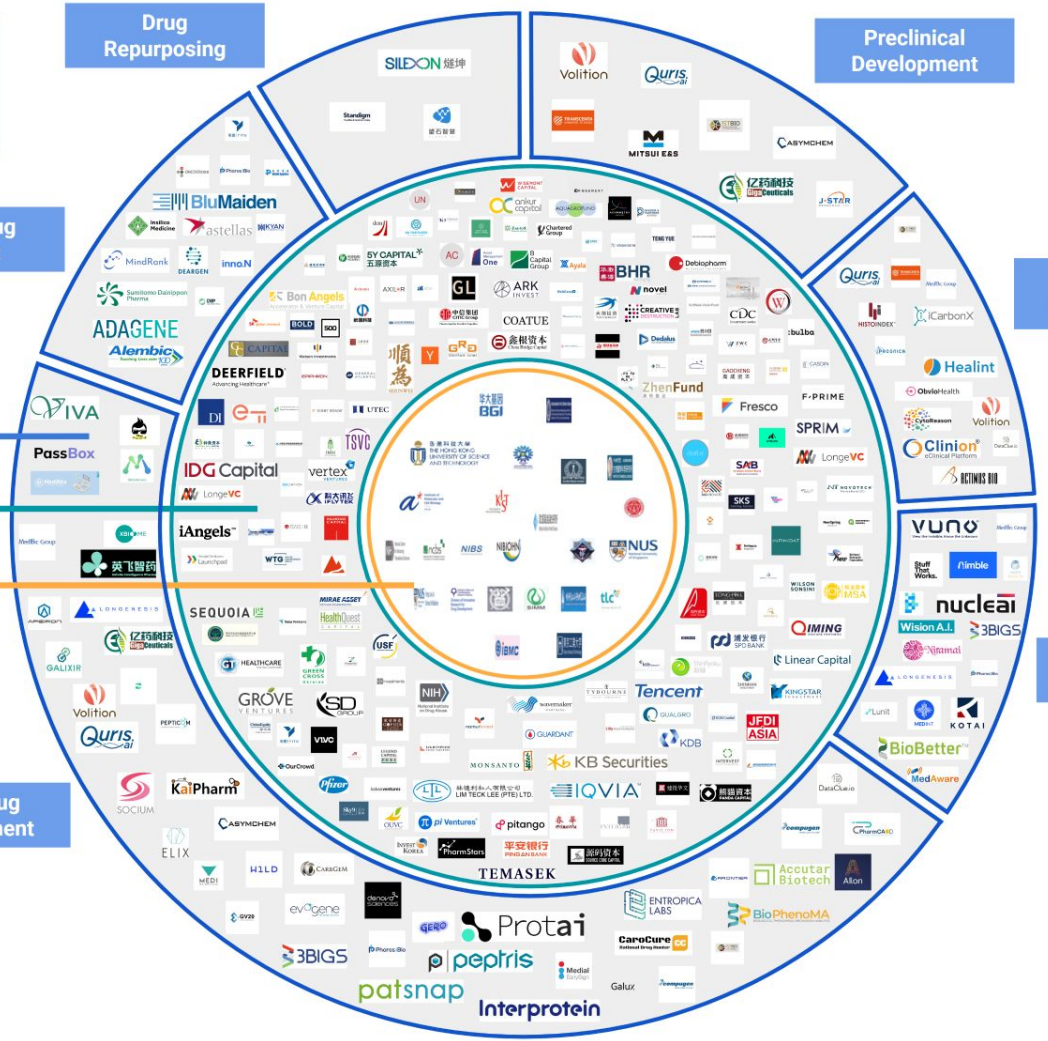
AI Companies — 800
Investors — 1,900
Corporations — 90
Hubs — 30

DEEP PHARMA INTELLIGENCE

View More at www.deep-pharma.tech

Artificial Intelligence in Drug Discovery in Asia Q4 2023

Companies — 130
Investors — 350
Hubs — 25



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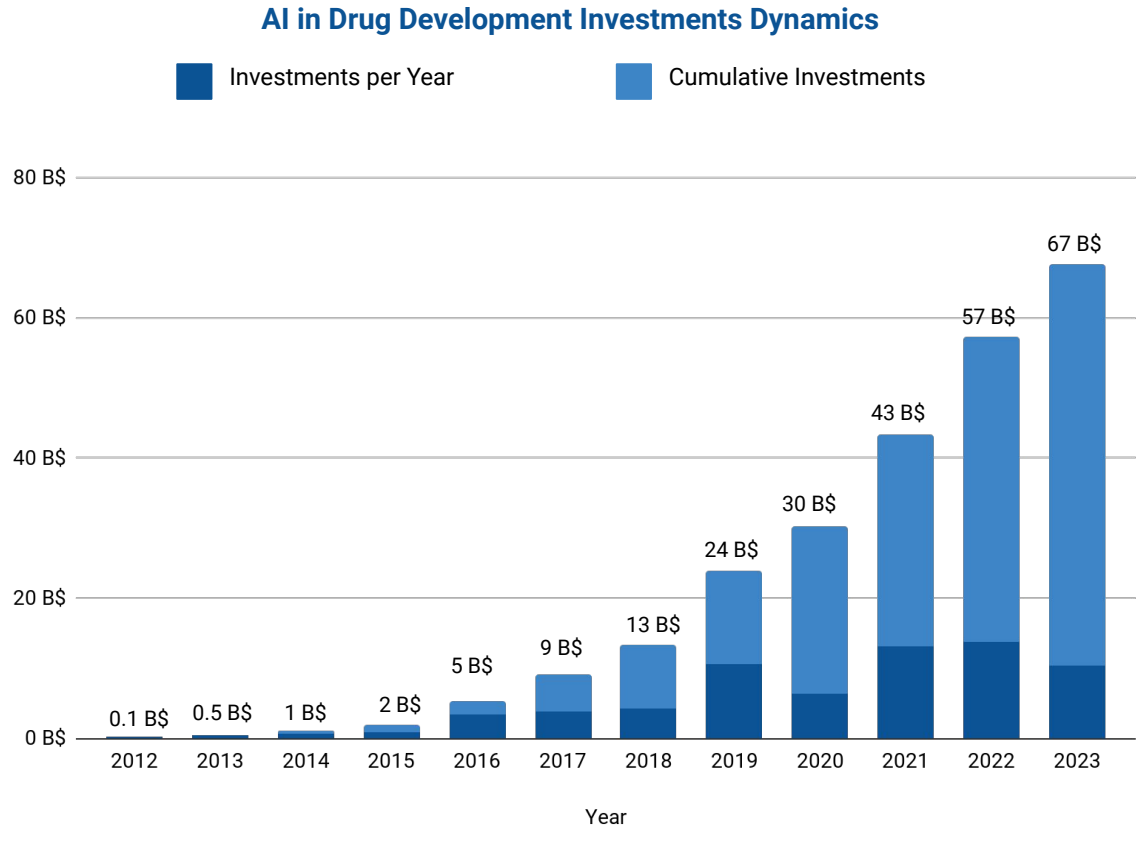
www.deep-pharma.tech

Investment Landscape

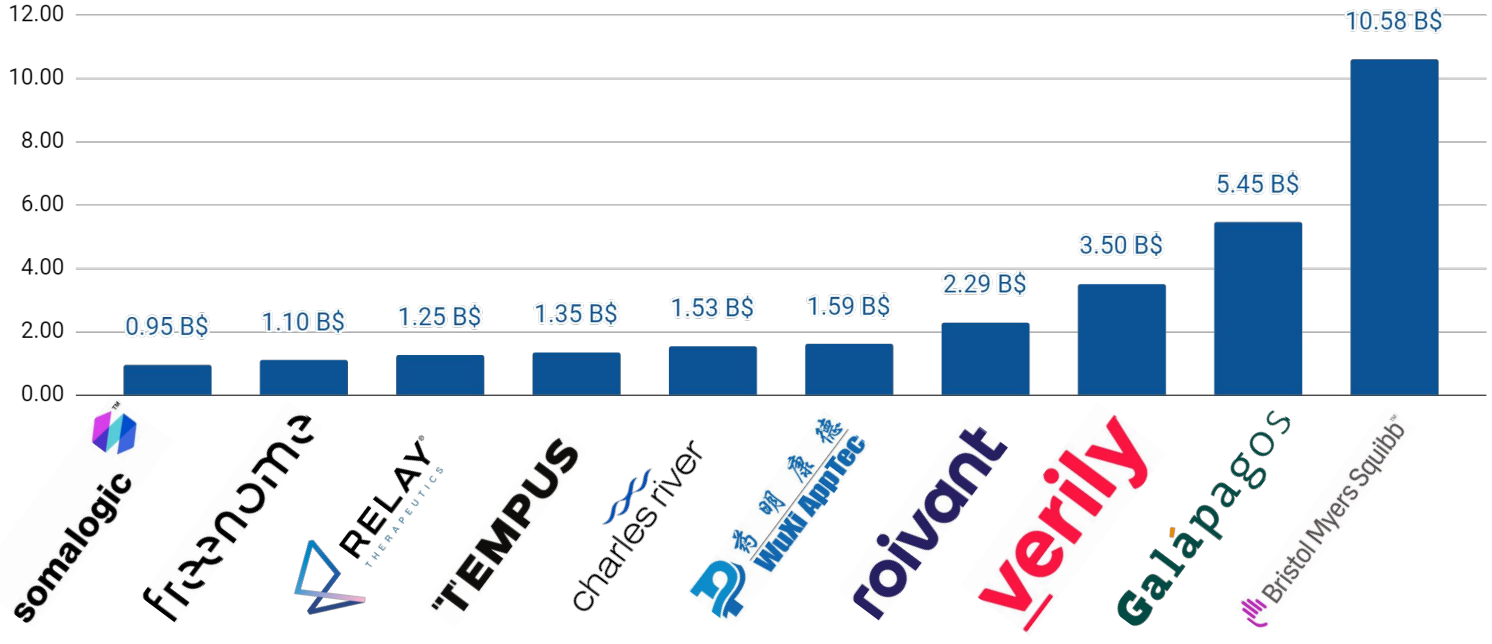
Dynamics of Investments in AI in Pharma



Capital inflow into AI-driven pharmaceutical firms surged significantly since 2015. In eleven years, investments in 800 companies soared almost 60 times, hitting $24.62 billion by December 2022. The peak was in 2021, with **$9.66 billion** invested in AI in Pharma. However, amidst the global economic downturn, 2022 witnessed a plunge to $3.63 billion, 2.6 times less than 2021. Despite this, by December 2022, total investments stood at $24.62 billion.

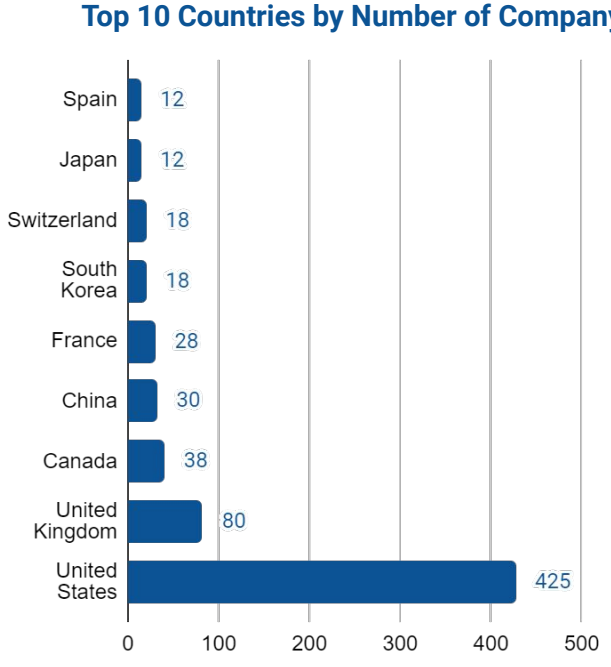
In 2023, there was a rebound, showcasing positive growth, with investments totalling **$10.39 billion**, culminating in a cumulative investment of **$67.56 billion** by year-end.

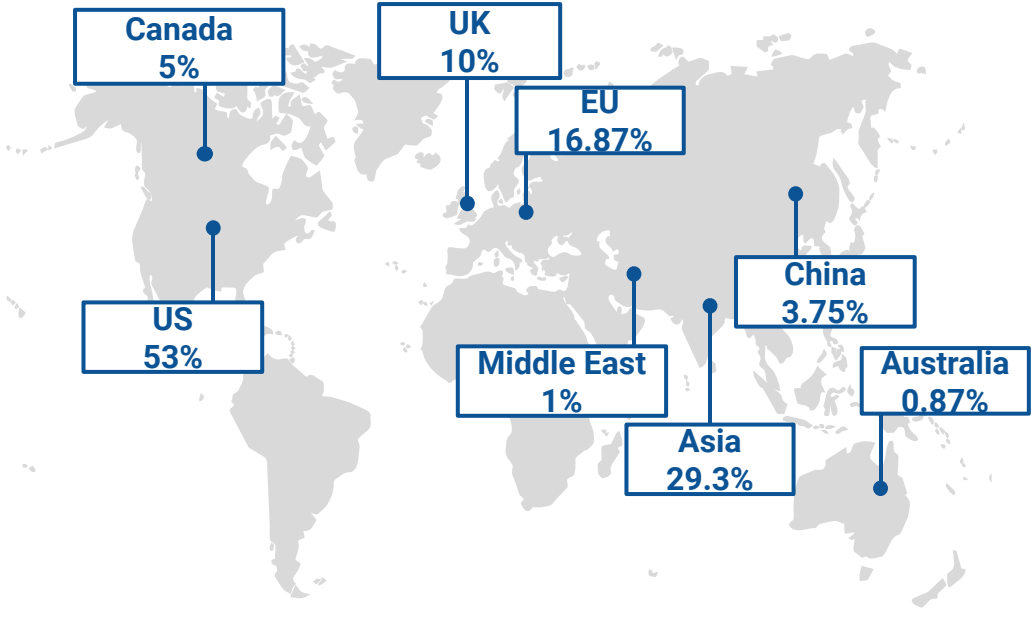
Top 10 AI in Pharma Companies by Total Investments in Q4 2023



The chart shows the top 10 AI-driven drug discovery companies sorted by the **total funding** raised by the end of Q4 2023. **Bristol Myers Squibb** leads the pack with an impressive **$6.08 billion** in total funding, demonstrating its expertise in pharmaceutical development. **Galapagos** closely follows with **$5.45 billion**, specializing in clinical-stage biotechnology and small molecule medicines. **Verily secures $3.5 billion**, highlighting its focus on health data research and disease management.

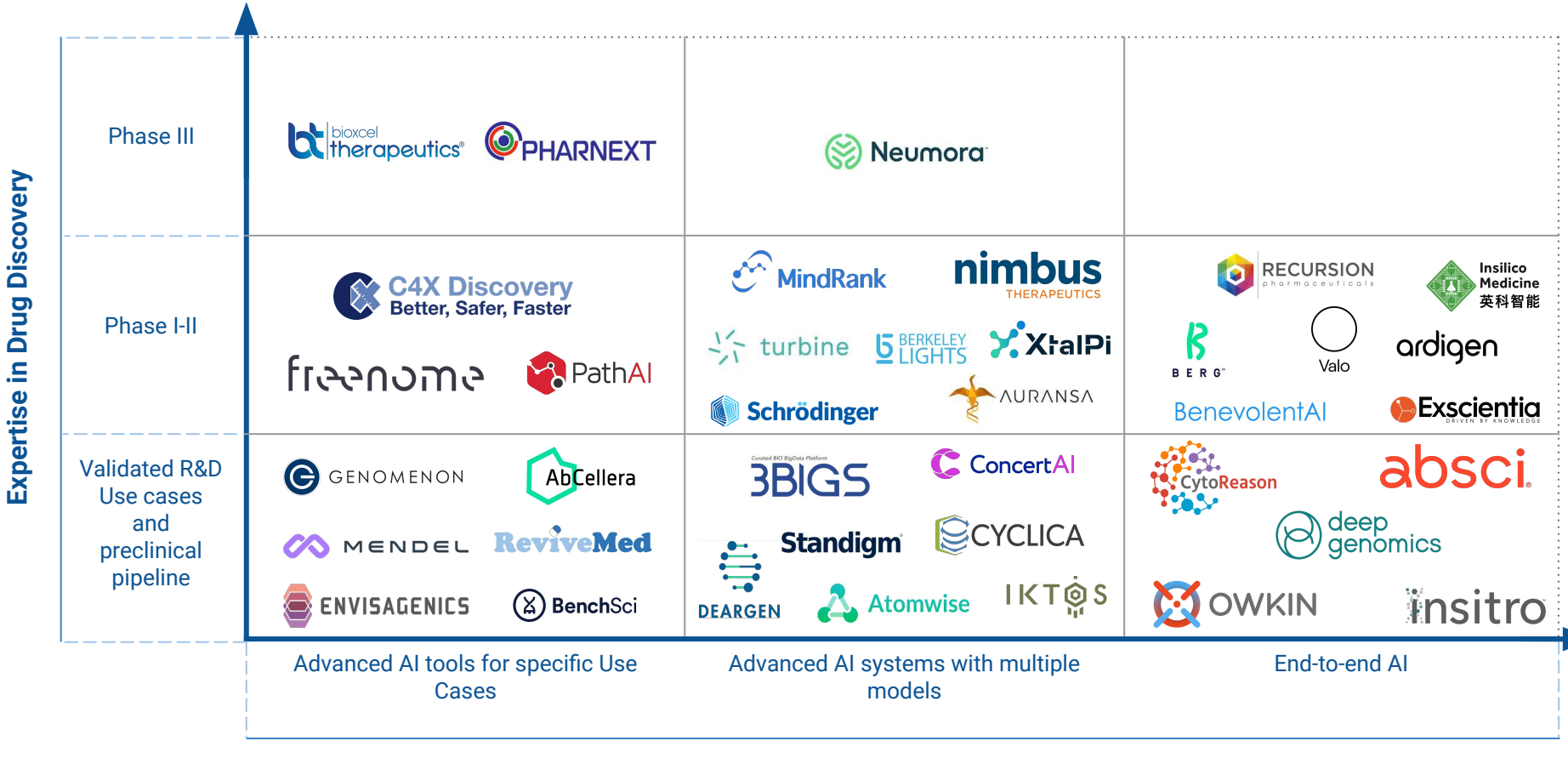
800 AI in Pharma Companies: Regional Proportion



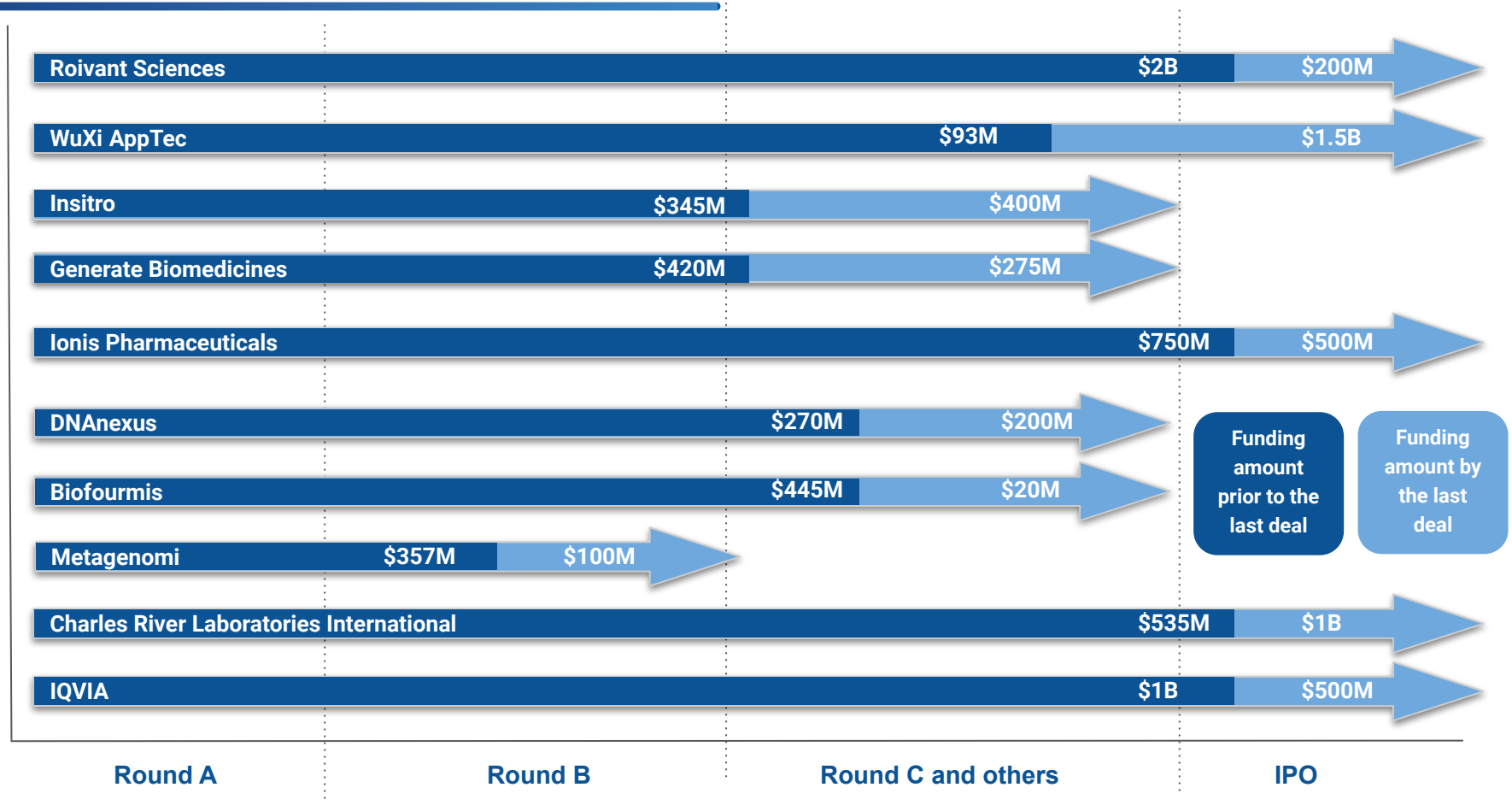


The US is still firmly in the lead regarding its proportion of AI in Pharma companies **425 companies (53%)**. Interestingly, Asia and the Middle East continue to expand usage of AI technologies in the Pharmaceutical Industry. The ratio of companies that use AI for Drug Development in the UK and European countries is decreasing compared to the Asian market. The Asia-Pacific region continues to aggressively increase the number of AI for Drug Discovery Companies, particularly in China, and this tendency will probably maintain.

Comparison of Top-40 Leading AI in Pharma Companies with Expertise in Drug Discovery R&D



Leading Companies by Amount and Stage of Funding



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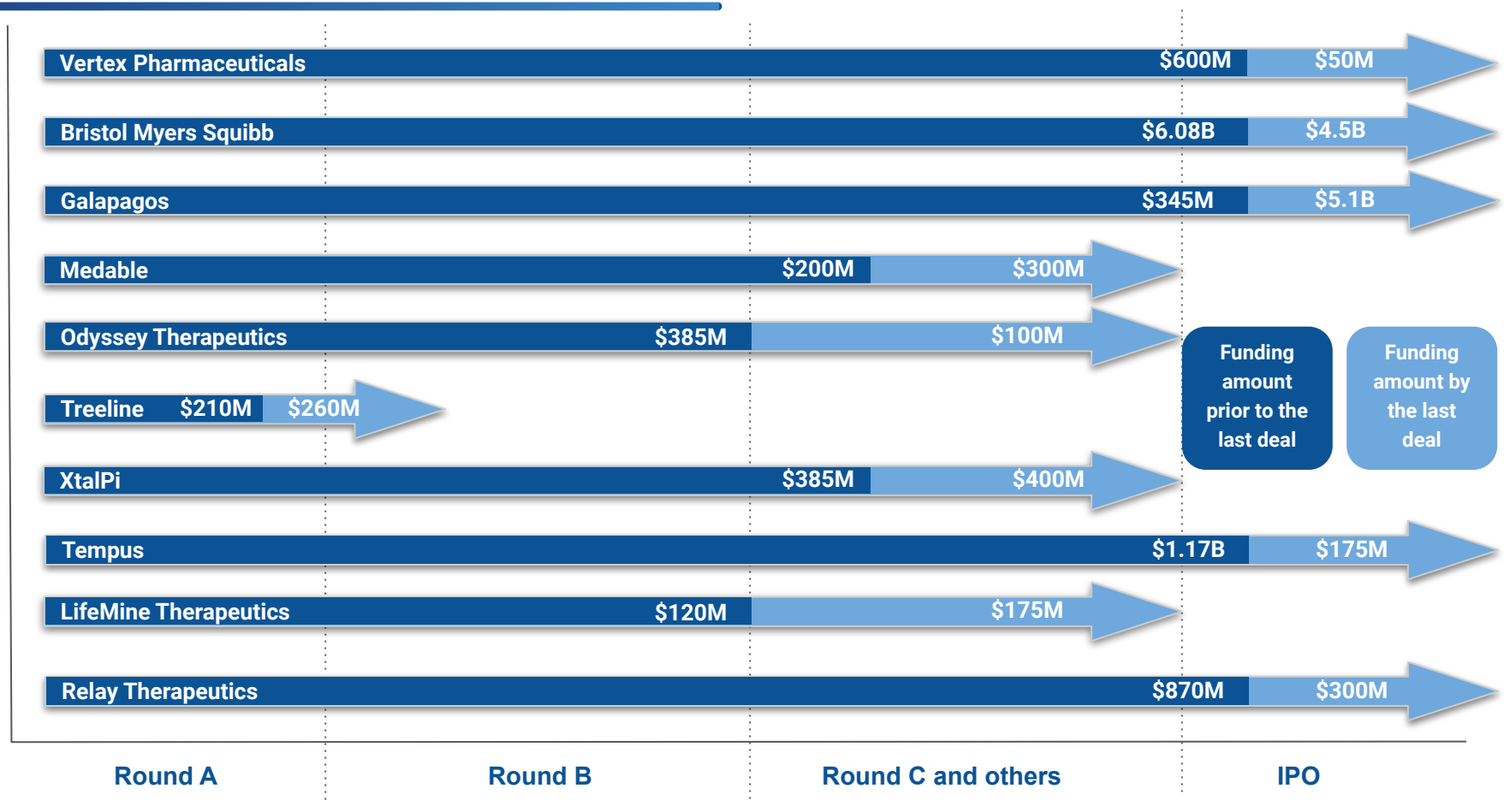
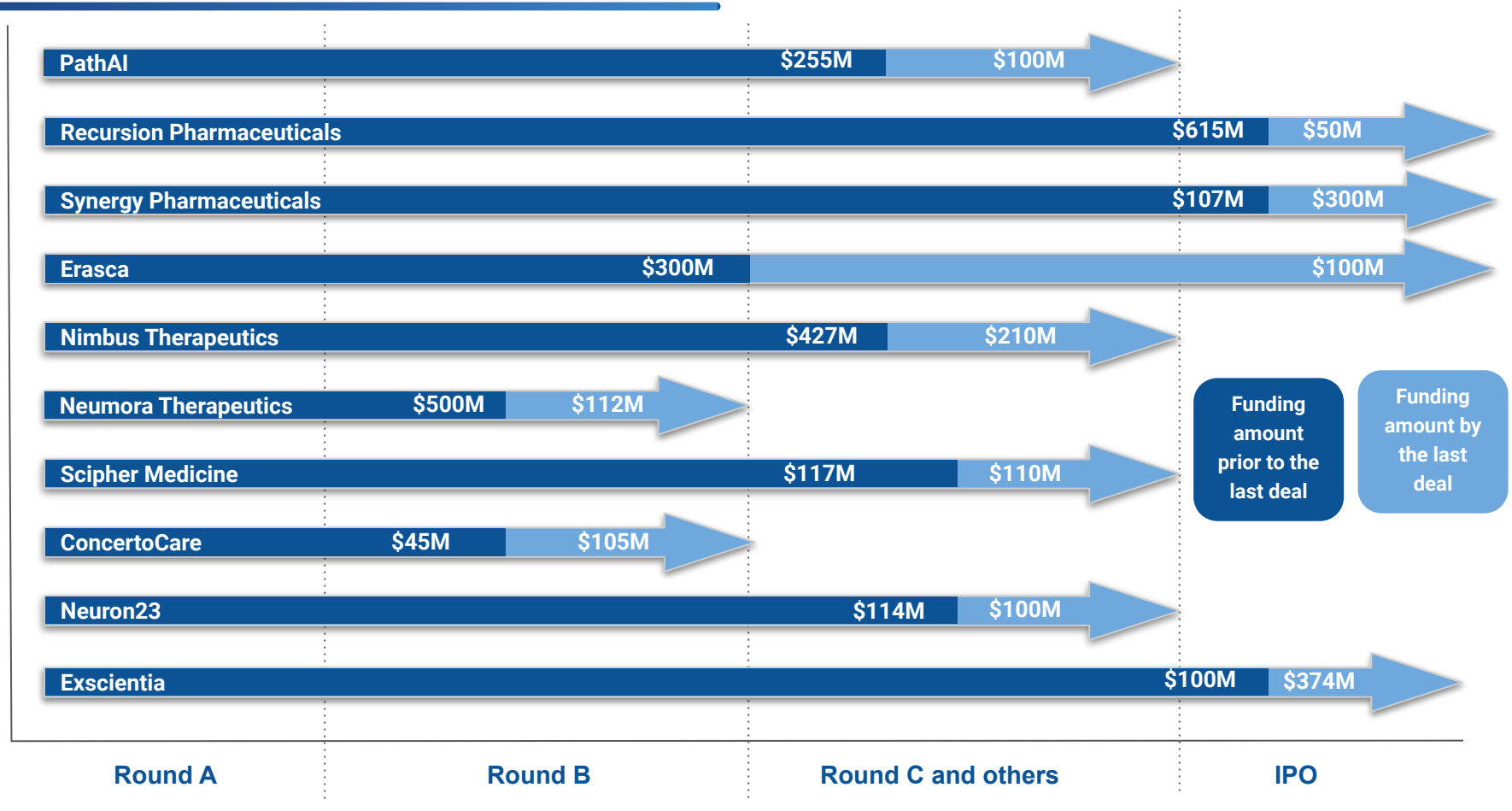
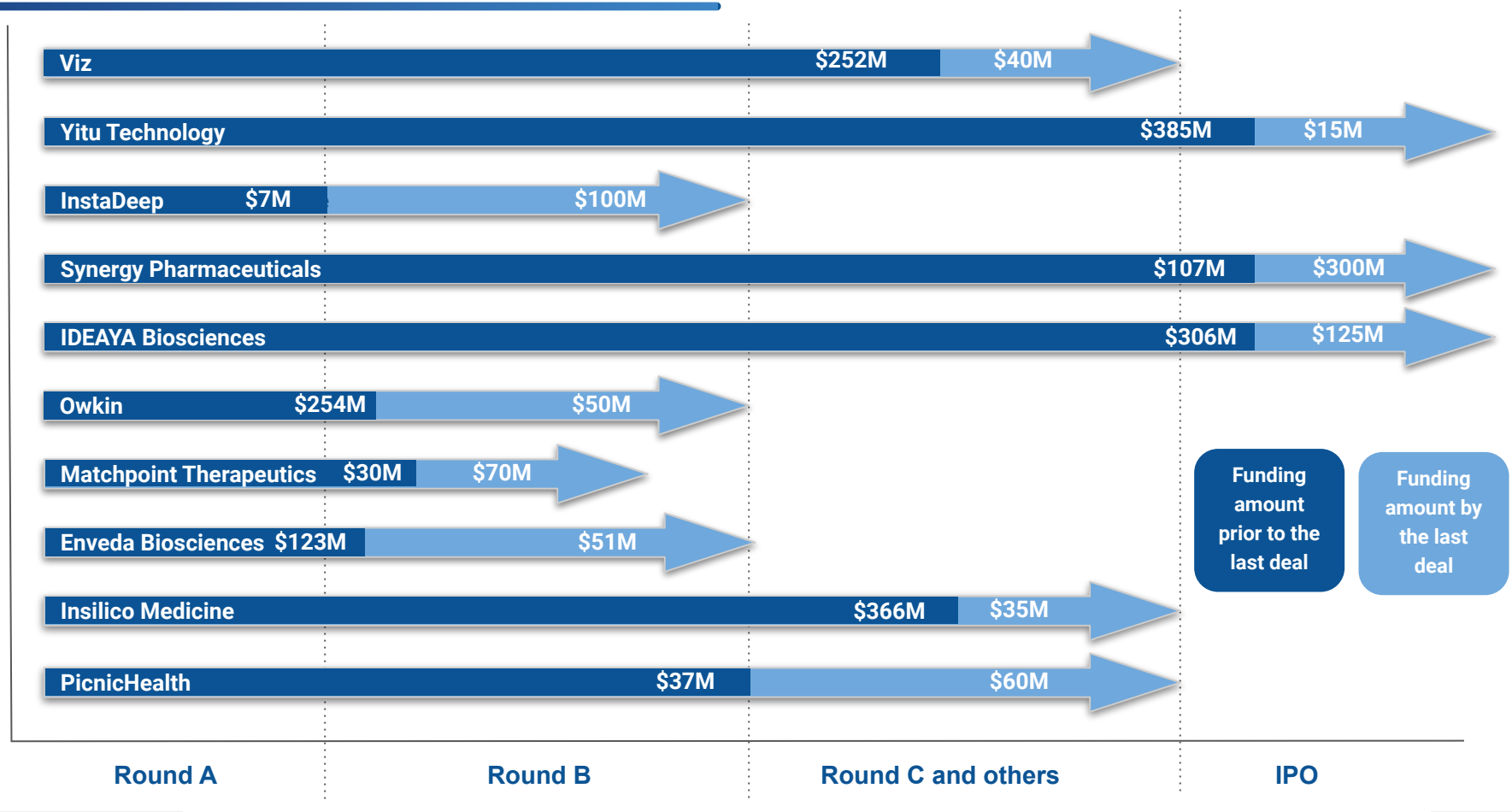


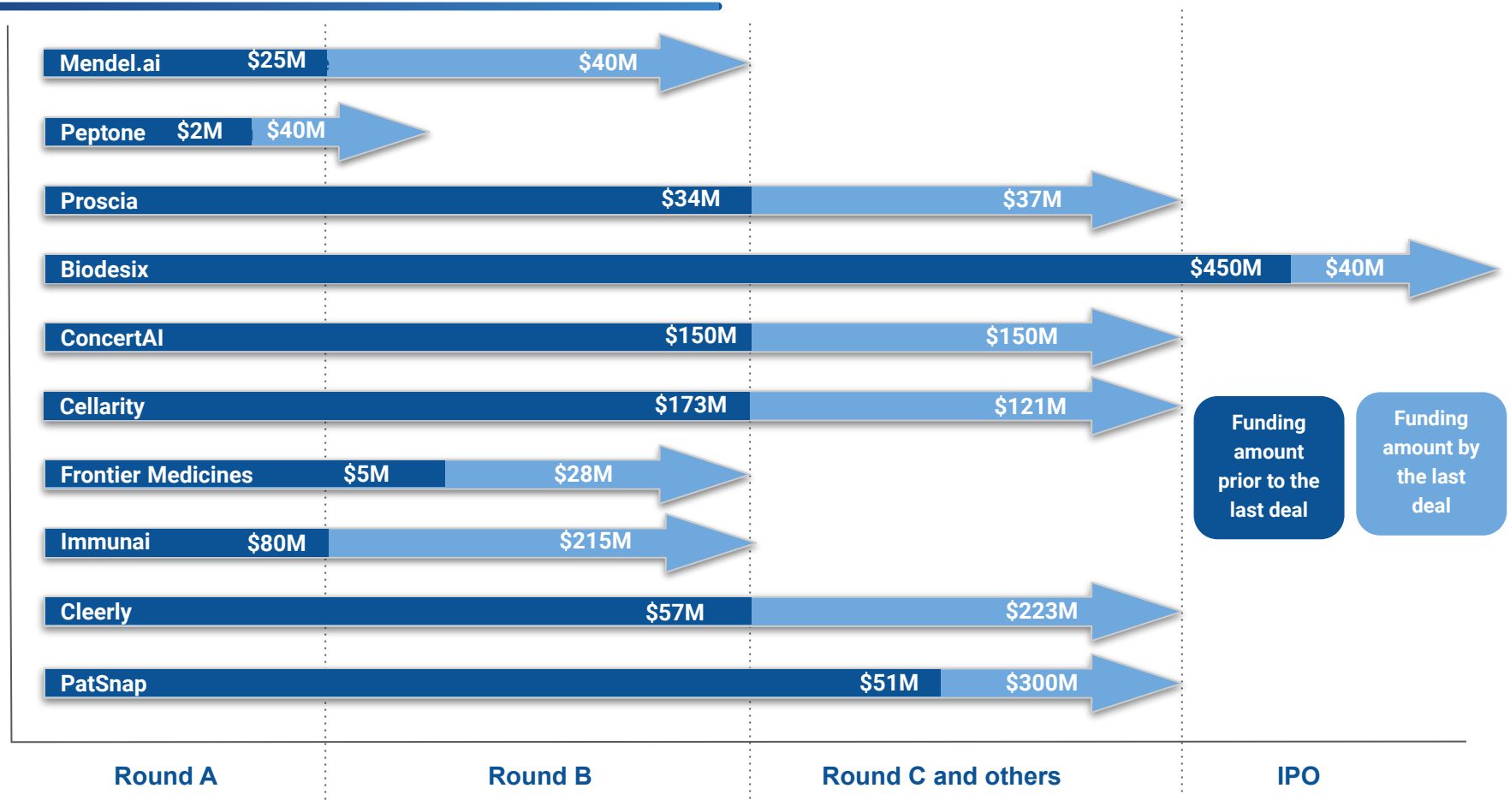
Leading Companies by Amount and Stage of Funding



Leading Companies by Amount and Stage of Funding

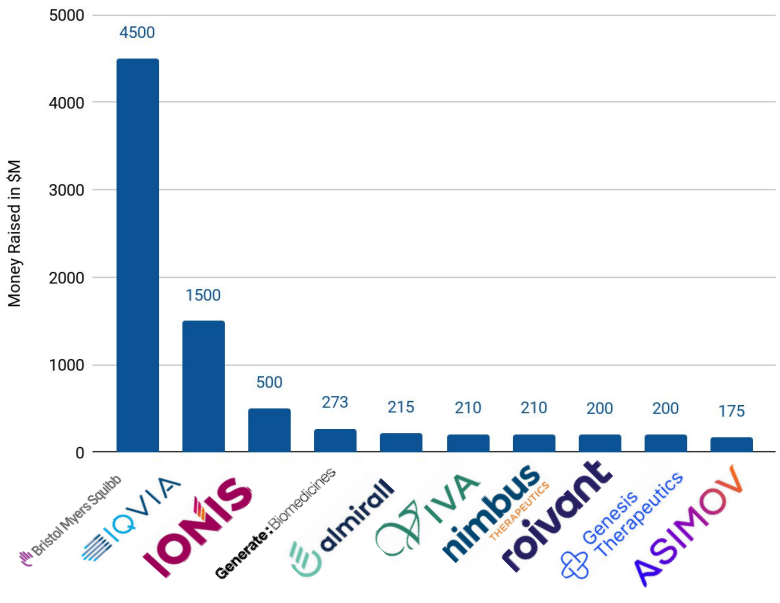


Leading Companies by Amount and Stage of Funding

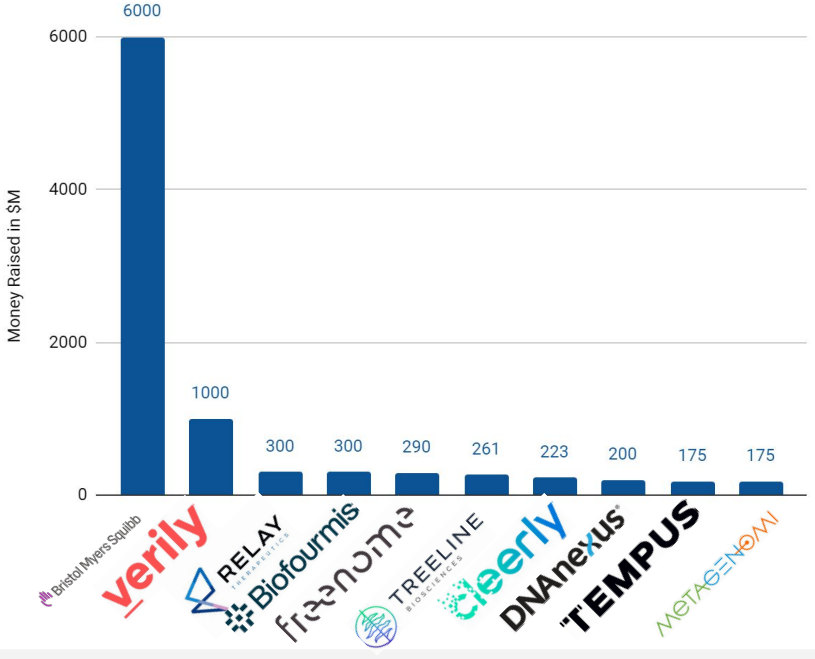


Top 10 Funded Companies in 2023 vs 2022

Top 10 Funded Companies in 2023



Top 10 Funded Companies in 2022



To visualise yearly trends, the charts represent the **top 10 funded companies in 2023 and 2022**. The observed central tendency is the decrease in investments in 2023 compared to 2022. The most significant raised investment in **2023** was **Bristol Myers Squibb** company, which raised **$4.5B**, but in **2022** company raised **$6B**. Despite that the **average investment in 2023** was **$97M**, while in **2022, it was $73.7M**, the number of assets is almost two times smaller in 2022 (**137 investments in 2022 to 232 investments in 2023**).

50 Leading Investors in AI Pharma Companies

50 Leading Investors in AI Pharma Companies

1	Casdin Capital
2	Y Combinator
3	GV
4	Creative Destruction Lab (CDL)
5	Perceptive Advisors
6	Alexandria Venture Investments
7	EASME
8	National Science Foundation
9	MassChallenge
10	Khosla Ventures
11	Invus
12	SoftBank Vision Fund
13	Andreessen Horowitz
14	ARCH Venture Partners
15	ZhenFund
16	F-Prime Capital
17	General Catalyst
18	Merck Global Health
19	RA Capital Management
20	Bill & Melinda Gates Foundation
21	Foresite Capital
22	T. Rowe Price
23	Obvious Ventures
24	Lux Capital
25	Alumni Ventures
26	Section 32
27	Sequoia Capital China
28	8VC
29	SOSV
30	Felicis Ventures
31	B Capital Group
32	Amgen Ventures
33	Entrepreneur First
34	DCVC
35	AME Cloud Ventures
36	Founders Fund
37	OrbiMed
38	Lifeforce Capital
39	Lilly Asia Ventures
40	Polaris Partners
41	Redmile Group
42	DCVC Bio
43	New Enterprise Associates
44	Tencent
45	WuXi AppTec
46	Novo Holdings
47	Amplitude Venture Capital
48	Biotechnology Value Fund
49	Madrona
50	Logos Capital

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
- **Amgen Ventures** — San Francisco, California, US
- **Redmile Group** — San Francisco, California, US
- **Biotechnology Value Fund** — San Francisco, California, US
- **Logos Capital** — San Francisco, California, US

New York

- **OrbiMed** — New York, New York, US
- **Bill & Melinda Gates Foundation** — New York, New York, US
- **Perceptive Advisors** — New York, New York, US
- **Invus** — New York, New York, US
- **Casdin Capital** — New York, New York, US
- **Lux Capital** — New York, New York, US

Menlo Park

- **Andreessen Horowitz** — Menlo Park, California, US
- **Felicis Ventures** — Menlo Park, California, US
- **Khosla Ventures** — Menlo Park, California, US
- **New Enterprise Associates** — Menlo Park, California, US

Illinois

- **ARCH Venture Partners** — Chicago, Illinois, 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

Massachusetts

- **MassChallenge** — Boston, Massachusetts, US
- **RA Capital Management** — Cambridge, Massachusetts, US
- **General Catalyst** — Cambridge, Massachusetts, US
- **Polaris Partners** — Boston, Massachusetts, US
- **F-Prime Capital** — Cambridge, Massachusetts, US

Manhattan Beach

- **B Capital Group** — Manhattan Beach, California, US

Other States

- **Merck Global Health Innovation Fund** — Whitehouse, New Jersey,US
- **Alumni Ventures** — Manchester, New Hampshire, US
- **SOSV** — Princeton, New Jersey, US
- **National Science Foundation** — Alexandria, Virginia, , US
- **T. Rowe Price** — Baltimore, Maryland, US
- **Section 32** — San Diego, California, US
- **Madrona** — Seattle, Washington, US

Canada

- **Amplitude Venture Capital** — Montréal, Quebec, Canada
- **Creative Destruction Lab (CDL)** — Toronto, Canda

Denmark

- **Novo Holdings** — Hellerup, Hovedstaden, Denmark

Beijing

- **ZhenFund** — Beijing, China
- **Sequoia Capital China** — Beijing, China

Shanghai

- **WuXi AppTec** — Shanghai, China
- **Lilly Asia Ventures** — Shanghai, China
- **Tencent** — Shenzhen, China

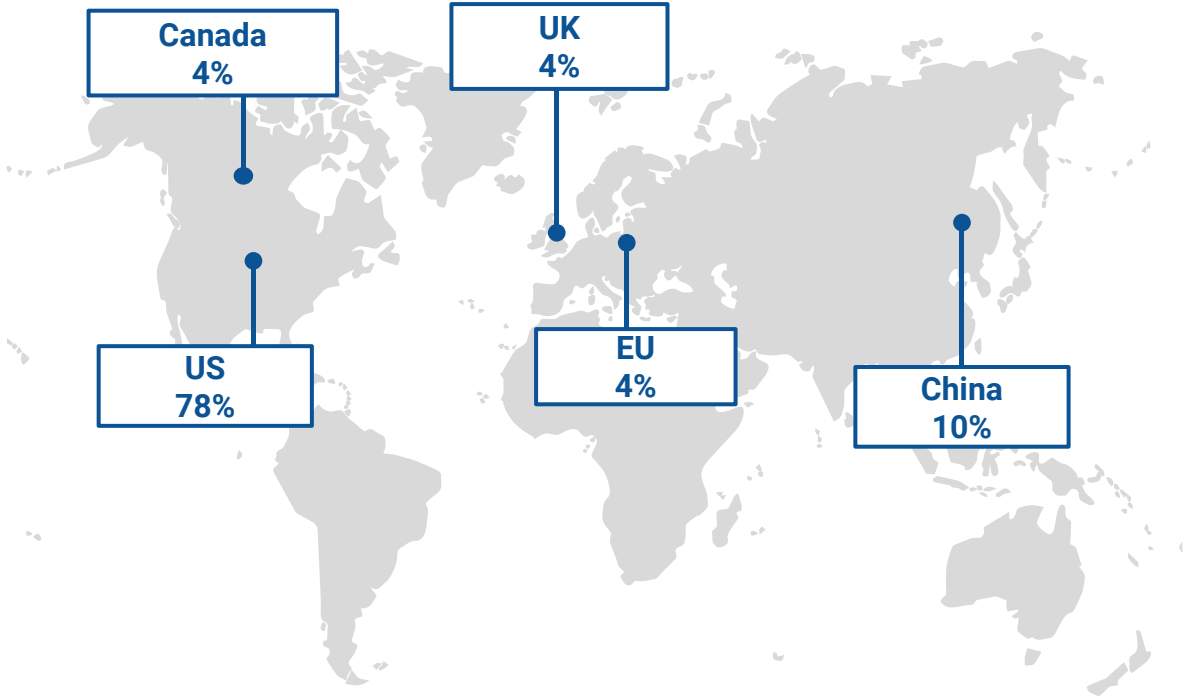
Belgium

- **EASME** — Brussels, Belgium

United Kingdom

- **SoftBank Vision Fund** — London, England, The UK
- **Entrepreneur First** — London, England, The UK

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 2023 we can observe significant growth of the number of investors in Asia, mainly in China. The USA, the UK, Canada, and EU remain to be leaders by the number of investors in AI in Pharma companies.

Sources: *Investment Digest AI in Pharma*

Top-50 Investors in AI Companies

INVESTORS	INVESTMENTS OVERALL	AI FOR DRUG DISCOVERY COMPANIES	INVESTED IN
Casdin Capital	220	28	Absci, Alector, Arzeda, Asimov, Beacon Biosignals, Celsius Therapeutics, Exscientia, Gritstone Oncology, Fabric Genomics, Flatiron Health, Foundation Medicine, Lunit, Insitro, Paige, Recursion Pharmaceuticals, Relay Therapeutics, Sema4, ShouTi, SomaLogic, Treeline Biosciences, Character Biosciences, SomaLogic, Structure Therapeutics, Treeline Biosciences, Imagen Technologies, Exai Bio, Dyno Therapeutics
Y Combinator	5,969	20	Arpeggio Bio, Athelas, Atomwise, CloudMedx, Coral Genomics, HistoWiz, iLabService, Menten AI, Notable Labs, Ochre Bio, PostEra, Reverie Labs, Segmed, Stratos, Verge Genomics, Nabla Bio, Darmiyan, Synkrino Biotherapeutics, Known Medicine, Gen1E Lifesciences
GV	1,009	19	Alector, Arrakis Therapeutics, Celsius Therapeutics, DNAnexus, Gritstone Oncology, IDEAYA Biosciences, Insitro, Flatiron Health, Foundation Medicine, Owkin, Relay Therapeutics, Schrödinger, Strateos, Treeline Biosciences, Ultromics, ZappRx, Imagen Technologies, LifeMine Therapeutics, Dyno Therapeutics
Creative Destruction Lab	764	15	OrganoTherapeutics, Epistemic AI, Altis Labs, NetraMark, biotx.ai, DeepCure, DeepLife, Entropica Labs, Kuano, Kyndi, Menten AI, ProteinQure, Winterlight Labs, Valence Discovery, Nostos Genomics
Perceptive Advisors	242	15	Absci, Alector, Black Diamond Therapeutics, Champions Oncology, DNAnexus, Icosavax, IDEAYA Biosciences, Neuron23, Saama, Sema4, Soma Logic, Relay Therapeutics, Biodesix, Landos Biopharma, Achilles Therapeutics
Alexandria Venture Investments	235	15	Arrakis Therapeutics, Celsius Therapeutics, Deep Genomics, GNS Healthcare, Gritstone Oncology, IDEAYA Biosciences, Immunai, Insitro, Fountain Therapeutics, LEXEO Therapeutics, Neuromora Therapeutics, Veralox Therapeutics, Matchpoint Therapeutics, Ozette Technologies, Terray Therapeutics
EASME	3,680	14	Cytox, Optellum, Quibim, OmicX, Genialis, Acellera, Genome Biologics, Iris.ai, CellPly, MedAware, Castor, Mind the Byte, InterAx Biotech Ltd
National Science Foundation	4,425	13	bioSyntagma, ADM Diagnostics, Strados Labs, Bioz, Cloud Pharmaceuticals, Data2Discovery Inc, TeselaGen, Nabla Bio, VeriSIM Life, Dascena, SpIntellx, VeriSIM Life, Canomiks
MassChallenge	3,156	12	OrganoTherapeutics, Agamon, Simply Speak, Scailyte, Strados Labs, ChemAlive sA, Vyasa Analytics, Neuroelectrics, Kintsugi, Clemedi, Canomiks, Thermy
Khosla Ventures	1,145	11	Arpeggio Bio, Atomwise, BIOAGE LABS, Fountain Therapeutics, Deep Genomics, Menten AI, Ochre Bio, Scipher Medicine, ThoughtSpot, Known Medicine, Gen1E Lifesciences

Top-50 Investors in AI Companies

INVESTORS	INVESTMENTS OVERALL	AI FOR DRUG DISCOVERY COMPANIES	INVESTED IN
Invus	206	11	Engine Biosciences, Recursion Pharmaceuticals, Erasca, Engine Biosciences, Schrödinger, Valo Health, Black Diamond Therapeutics, ITeos Therapeutics, Neumora Therapeutics, LifeMine Therapeutics, Achilles Therapeutics
SoftBank Vision Fund	430	10	Biofourmis, Datavant, Deep Genomics, Exscientia, Insitro, PatSnap, Relay Therapeutics, Roivant Sciences, XtalPi, Neuron23
Andreessen Horowitz	1,468	10	Aria Pharmaceuticals, Asimow, BigHat Biosciences, BIOAGE LABS, Erasca, Flatiron HealthGenesis Therapeutics, Insitro, Freenome, Dyno Therapeutics
ARCH Venture Partners	465	10	Arbor Biotechnologies, Generate Biomedicines, Glympse Bio, Erasca, Hangzhou Just Biotherapeutics (Just China), Insitro, Treeline Biosciences, Neumora Therapeutics, Vilya, LifeMine Therapeutics
ZhenFund	774	9	AccutarBio, Deep Intelligent Pharma, HistoWiz, Spring Discovery, uBiome, Xbiome, XtalPi, Yitu Technology, Meliora Therapeutics
F-Prime Capital	432	9	Adagene, BenchSci, Insilico Medicine, Notable, Neuromora Therapeutics, Owkin, Elucidata, Peptone, Castor
General Catalyst	1,228	9	Athelas, Beacon Biosignals, PathAI, Spring Discovery, Swoop, ThoughtSpot, Odyssey Therapeutics, OM1, LatchBio
Merck Global Health Innovation Fund	90	8	PathAI, Strata Oncology, PreciseDx, Antidote.me, Absci, OpGen, Turbine, Verge Genomics
RA Capital Management	358	8	Everest Medicines, Freenome, Frontier Medicines, Bristol Myers Squibb, Icosavax, Nimbus Therapeutics, Wave Life Sciences, Achilles Therapeutics
Bill & Melinda Gates Foundation	274	8	Atomwise, Evotec, Exscientia, Foundation Medicine, Novartis, Schrödinger, Takeda, Cyclica

Top-50 Investors in AI Companies

INVESTORS	INVESTMENTS OVERALL	AI FOR DRUG DISCOVERY COMPANIES	INVESTED IN
Foresite Capital	149	8	Aetion, Alector, DNAnexus, Generate Biomedicines, Insitro, Relay Therapeutics, Wave Life Sciences, Odyssey Therapeutics
T. Rowe Price	334	8	Arbor Biotechnologies, Generate Biomedicines, Genesis Therapeutics, Insitro, Sema4, SomaLogic, Tempus, Odyssey Therapeutics
Obvious Ventures	154	8	ConcertoCare, Inato, LabGenius, Medable, Recursion Pharmaceuticals, Gandeeva Therapeutics, Meliora Therapeutics, Dyno Therapeutics, Achilles Therapeutics
Lux Capital	460	8	Alife, Auransa, LabGenius, Recursion Pharmaceuticals, Strateos, LatchBio, Gandeeva Therapeutics, Dyno Therapeutics
Alumni Ventures	1,461	8	Scipher Medicine, Unlearn.AI, Notable Labs, Olaris, Strateos, Veralox Therapeutics, Verge Genomics, Juvena Therapeutics, Emerald Cloud Lab
Section 32	113	8	Character Biosciences, Nucleai, BigHat Biosciences, Celsius Therapeutics, Verge Genomics, Glympse Bio, Alector, Exai Bio
Sequoia Capital China	1,028	8	HiFiBiO, METiS Therapeutics, PatSnap, XtalPi, Adagene, Deep Intelligent Pharma, Transcenta, Exai Bio
8VC	453	7	BigHat Biosciences, Coral Genomics, Immunai, Model Medicine, Notable, ProteinQure, Unlearn.AI
SOSV	2,655	7	A2A Pharmaceuticals, Gatehouse Bio, Guided Clarity, Mendel.ai, Stelvio Therapeutics, Strados, Synthace
Felicis Ventures	612	7	BIOAGE LABS, Genesis Therapeutics, Juvena Therapeutics, LabGenius, ProteinQure, Spring Discovery, PicnicHealth

Top-50 Investors in AI Companies

INVESTORS	INVESTMENTS OVERALL	AI FOR DRUG DISCOVERY COMPANIES	INVESTED IN
B Capital Group	206	7	Aetion, Atomwise, Insilico Medicine, Notable Labs, HiFiBiO, PicnicHealth, HotSpot Therapeutics
Amgen Ventures	113	7	GNS Healthcare, Neumora Therapeutics, BigHat Biosciences, Celsius Therapeutics, Alector, Gandeeva Therapeutics
Entrepreneur First	415	7	DeepLife, Entropica Labs, Exogene, Sparrho, GTN, Cinference, Nostos Genomics
DCVC	498	6	AbCellera Biologics, Asimov, Atomwise, Auransa, Strateos, Unlearn.AI
AME Cloud Ventures	302	6	Asimov, Atomwise, Auransa, BigHat Biosciences, BIOAGE LABS, Molecule.one
Founders Fund	872	6	AbCellera Biologics, Datavant, Emerald Cloud Lab, Notable Labs, Roivant Sciences, DeepMind
OrbiMed	633	6	AbCellera, Alector, Erasca, Insilico Medicine,Treeline Biosciences, XtalPi
Lifeforce Capital	53	6	Clover Therapeutics, Notable Labs, PostEra, TARA Biosystems, Verge Genomics, Character Biosciences
Lilly Asia Ventures	188	6	Gritstone Oncology, Hangzhou Just Biotherapeutics (Just China), Insilico Medicine, ShouTi, Transcenta, Structure Therapeutics
Polaris Partners	674	6	Freenome, OM1, Engine Biosciences, Alector, Neumora Therapeutics, Dyno Therapeutics

Top-50 Investors in AI Companies

INVESTORS	INVESTMENTS OVERALL	AI FOR DRUG DISCOVERY COMPANIES	INVESTED IN
Redmile Group	166	6	Absci, Neuron23, Foundation Medicine, Wave Life Sciences, Gritstone bio, Achilles Therapeutics
DCVC Bio	42	5	Empirico, Frontier Medicines, Totus Medicines, Unlearn.AI, X-37
New Enterprise Associates	2,154	5	Aetion, Black Diamond Therapeutics, Champions Oncology, Tempus, Vertex Pharmaceuticals
Tencent	780	5	Atomwise, Brainomix, iCarbonX, PatSnap, XtalPi
WuXi AppTec	43	5	Arrakis Therapeutics, Verge Genomics, Schrödinger, Engine Biosciences, WuXi AppTec
Novo Holdings	323	5	Evotec, Exscientia, Kebotix, Tempus, Metagenomi
Amplitude Venture Capital	24	5	Imagia, Celsius Therapeutics, Deep Genomics, Valence Discovery, Gandeeva Therapeutics
Biotechnology Value Fund	47	5	Evotec, IDEAYA Biosciences, Nimbus Therapeutics, Relay Therapeutics, Gritstone bio
Madrona	498	5	Ovation, Envisagenics, Ozette Technologies, Modulus Therapeutics, Terray Therapeutics
Logos Capital	104	5	Freenome, OM1, Engine Biosciences, Alector, Neumora Therapeutics, Dyno Therapeutics

Biggest Deals 2023

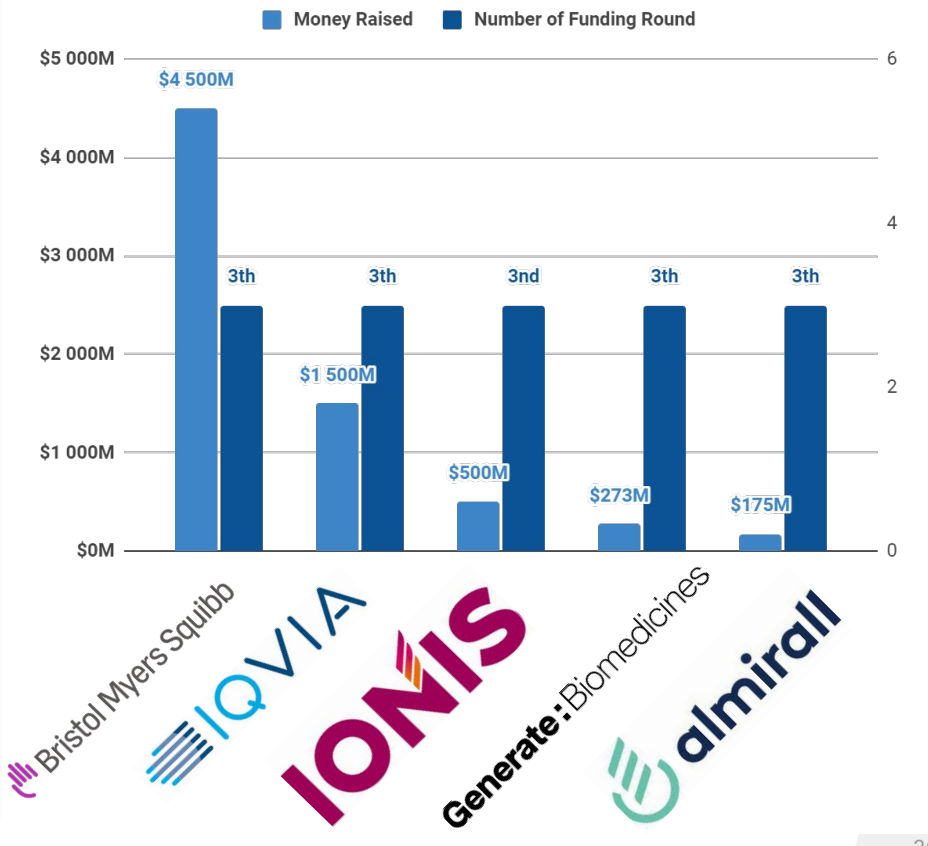
The total amount of VC funding in AI in pharma development companies reached to $26.5B in Q4 2023.

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-powered companies 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. **Bristol Myers Squibb** with $4.5 billion (Post-IPO Debt)
2. **IQVIA** with $1.5 billion (Post-IPO Debt)
3. **Ionis Pharmaceuticals** $500 million (Post-IPO Debt)
4. **Generate Biomedicines** with $273 million (Series C)
5. **Almirall** with $175 million (Post-IPO Equity)

Biggest Funding 2023

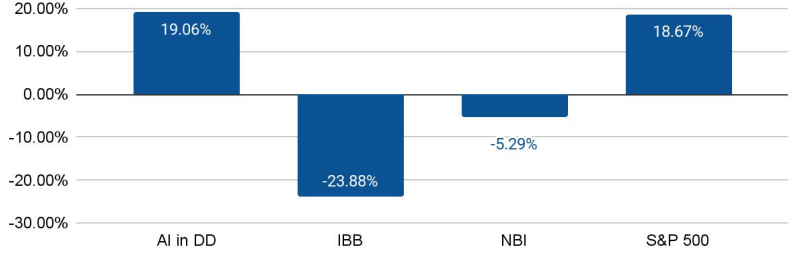


AI in Pharma
Publicly Traded Companies

AI in Pharma Publicly Traded Companies

Cumulative Capitalization of Publicly Traded AI-in-Drug Development Companies in 2023, $ Billion

Market Capitalization Growth During 2023



Despite the crisis and high volatility, AI in Drug Development publicly traded companies **reached $809,2B of cumulative capitalization as of December 7, 2023**. 69 AI in Drug Development companies were taken for this analysis, three of them have closed their IPO in 2023. **BullFrog AI** has closed its IPO in Q1 2023, **Neumora Therapeutics** have closed their IPOs in Q3 2023, **LEXEO Therapeutics** has closed its IPO in Q4 2023.

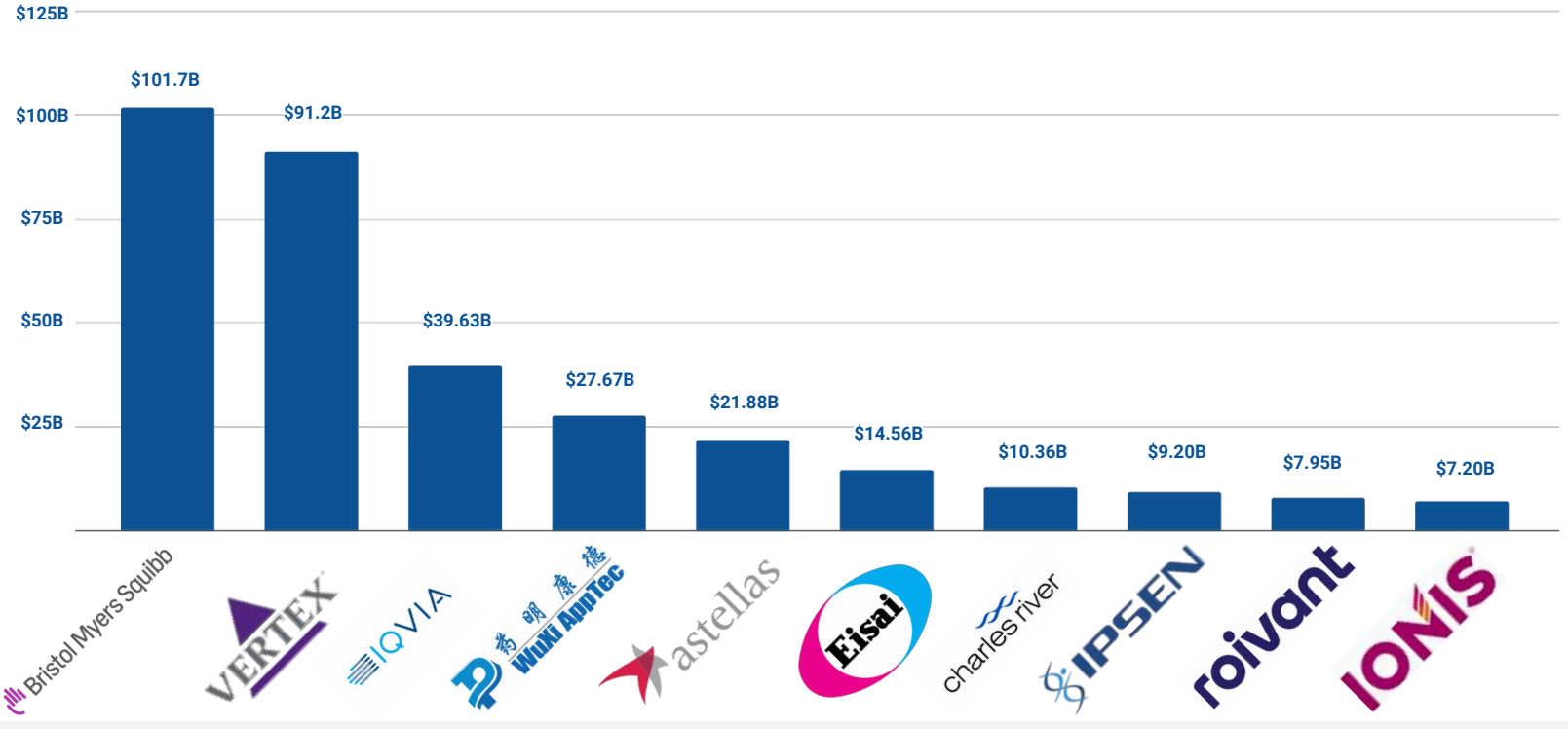
The largest companies by market capitalization are **Novo Nordisk, Bristol Myers Squibb** and **Vertex Pharmaceuticals.** The smallest market capitalization are in **Predictive Oncology**, **OpGen Inc.** and **Evolutionary Genomics**.

Overall, the AI in drug development industry has demonstrated resilience and growth despite the challenges and uncertainties of the past year.

It's essential to measure the performance of publicly traded AI in Drug Development companies via comparison with significant market benchmarks such as iShares Biotechnology ETF (IBB), YTD NASDAQ Biotechnology Index (NBI), and S&P 500 gained solid.

The total capitalization of publicly traded companies increased by 19.06%, the S&P 500 rose by 18.67%, while other indices fell to -23.88%.

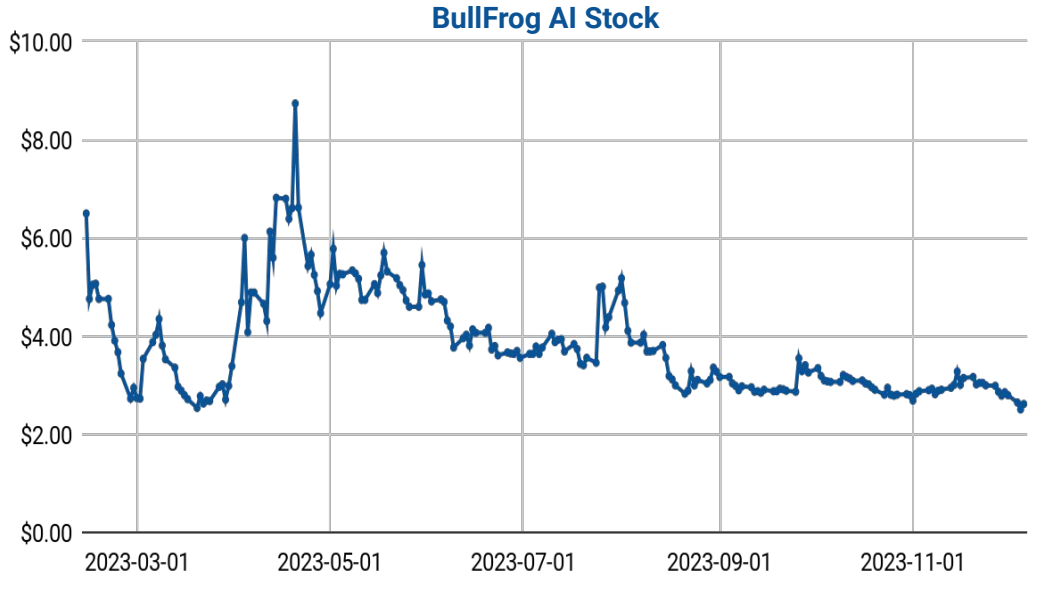
Top-10 AI-Driven Publicly Traded Pharma Companies by Market Capitalization in 2023



The chart presents the **Top-10 AI-driven drug discovery** public companies arranged by market capitalization as of end of December 2023. **Bristol-Myers Squibb Company**, United States-based healthcare company focused on applying technology to drug development. holds the first place with **$101.7B** of market capitalization.

AI in Pharma IPOs in 2023

In Q1 2023, BullFrog AI has successfully closed IPO.



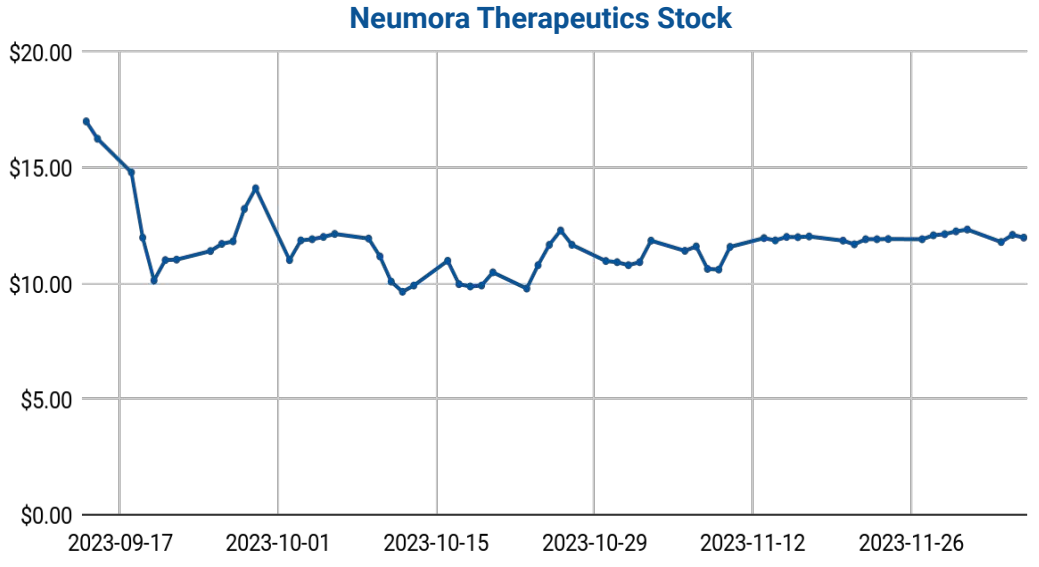
Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $M
BFRG	-0.01%	9.4%	-59.69%	$15.5M

Bullfrog AI Holdings, Inc., and its subsidiaries function as a digital biopharmaceutical company in the United States, specializing in the application of artificial intelligence and machine learning (AI/ML) for data analysis in medicine and healthcare. The company's portfolio includes bfLEAP, an AI/ML platform designed for the comprehensive analysis of preclinical and/or clinical data. Additionally, it holds licensing agreements with George Washington University, granting rights to employ siRNA targeting Beta2-spectrin for treating human diseases such as hepatocellular carcinoma, obesity, non-alcoholic fatty liver disease, and non-alcoholic steatohepatitis. Furthermore, Bullfrog AI has collaborations with Johns Hopkins University, allowing the utilization of a Mebendazole formulation for the treatment of human cancer or neoplastic disease.

The graph on the left depicts a comparative performance of Bullfrog AI on NasdaqCM starting 13.02.2023.

AI in Pharma IPOs in 2023

In Q3 2023, Neumora Therapeutics has successfully closed IPO.



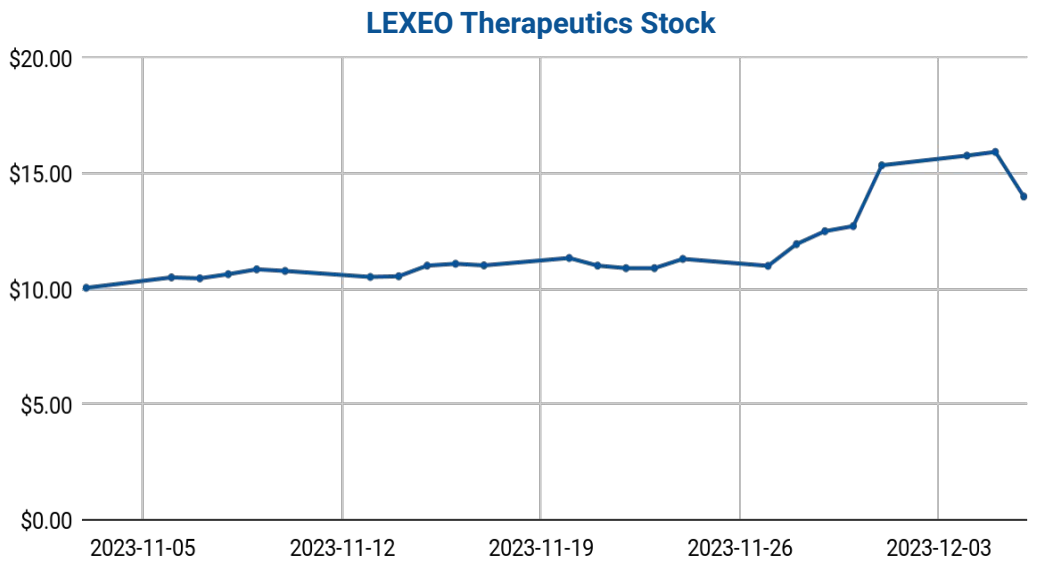
Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $M
NMRA	-0.36%	6.59%	-29.53%	$1.9B

Neumora Therapeutics, Inc., a clinical-stage biopharmaceutical company, is dedicated to developing therapeutic interventions for brain diseases, neuropsychiatric disorders, and neurodegenerative diseases. The company is actively advancing its pipeline, including NMRA-511 currently in phase 1 clinical trials for agitation associated with dementia due to Alzheimer's disease; NMRA-266 targeting schizophrenia and other neuropsychiatric disorders; NMRA-NMDA for schizophrenia treatment; NMRA-CK1d, an amyotrophic lateral sclerosis treatment through CK1d inhibition; NMRA-NLRP3 for specific neurodegenerative conditions; and NMRA-GCase designed for Parkinson's disease treatment.

The graph on the left depicts a comparative performance of Neumora Therapeutics on NasdaqGC starting 14.09.2023.

AI in Pharma IPOs in 2023

In Q3 2023, LEXEO Therapeutics has successfully closed IPO.



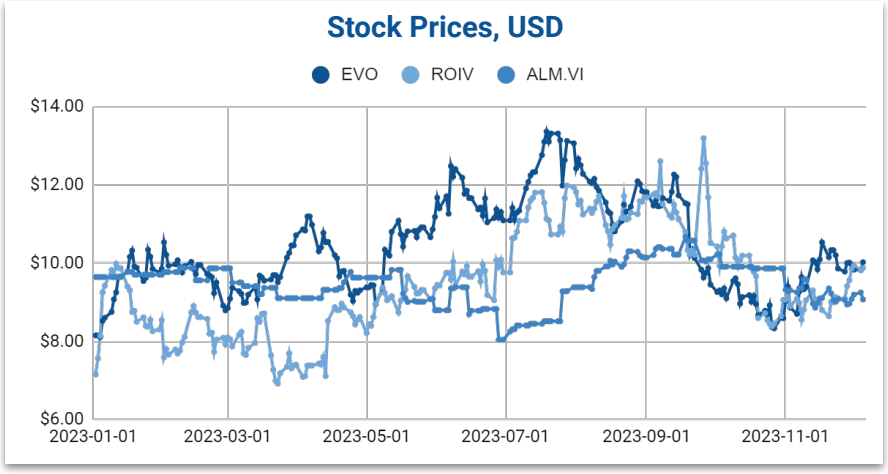
Ticker	Mean Daily Return	Volatility of Daily Returns	Growth after IPO	Capitalization, $M
LXEO	1.60%	5.69%	39.30%	$345.3M

Lexeo Therapeutics, Inc. Lexeo Therapeutics, Inc. functions as a clinical-stage genetic medicine company, concentrating on hereditary and acquired diseases. The company's developments include LX2006, an AAVrh10-based gene therapy for Friedreich's ataxia (FA) cardiomyopathy; LX2020, an AAVrh10-based gene therapy for arrhythmogenic cardiomyopathy; LX2021, a gene therapy for DSP cardiomyopathy linked to it; and LX2022, a gene therapy for HCM caused by TNNI3 mutations. Additional candidates comprise LX1001, an AAVrh10-based gene therapy for APOE4 homozygotes; LX1020, a gene therapy for APOE4 homozygotes; LX1021 for the treatment of APOE4 homozygotes; and LX1004 for CLN2 Batten disease treatment.

The graph on the left depicts a comparative performance of Bullfrog AI on NasdaqCM starting 3.11.2023.

Top AI in Pharma Best-Promising Companies in 2023

The analysis focuses on **Evotec**, **Roivant Sciences** and **Almirall**, a trio of promising companies that recently entered the market through IPOs in 2021 and 2022. The dynamic nature of their recent entry suggests that their trajectories may undergo significant changes in the future. These companies boast robust multi-target pipelines dedicated to developing innovative therapeutics that cater to unmet medical needs. The expectation is that they will successfully translate their proprietary insights and technical solutions into impactful therapeutic interventions. Presently, these companies enjoy a strong market position, leading to heightened investor expectations.



Name	Country	Funding Amount, $M	IPO Date	Capitalization, $B	Valuation at IPO, $B	IPO Share Price, $	Current Share Price, $	EV/ EBITDA	Net Income, $M
Evotec	Germany	741.7	04.11.2021	3.507	3.8	21.75	9.72	17.6X	-94.98
Roivant Sciences	UK	2300.0	01.10.2021	7.903	7.3	19.00	9.83	-7.2X	-1100.0
Almirall	Spain	200.0	30.12.2022	1.97	-	9.83	9.28	11.2X	6.98

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
AbCellera	1,426.19	-0.22%	3.31%	9.83%	1.7	1.2	699.34	-178.29	-211.24%	-3.9X
Absci	224.91	0.21%	6.06%	80.60%	2.6	2.7	124.53	-75.68	0.00%	-1.6X
Achilles Therapeutics	33.44	-0.07%	2.73%	-8.69%	0.4	0.4	-96.39	-66.98	0.00%	1.4X
Adagene	82.01	0.31%	5.50%	38.58%	0.4	0.4	-4.89	-39.28	100.00%	0.1X
Alector	487.15	-0.08%	4.77%	5.85%	2.1	1.0	-60.64	-154.04	-106.50%	0.4X
Almirall	1,921.16	-0.01%	1.57%	-0.70%	-0.2	-0.3	1,883.70	167.96	74.94%	11.2X
Astellas Pharma	21,875.55	-0.08%	1.51%	3.00%	0.2	0.4	550,242.42	263,774.00	81.62%	2.1X

The data reveals diverse financial profiles among the listed companies. Astellas Pharma stands out with the highest market capitalization of $21,875M, indicating its substantial market presence. AbCellera, on the other hand, shows concerning financial metrics with a negative EV/EBITDA ratio and a significant negative gross profit margin. Adagene displays a noteworthy 100% gross profit margin, suggesting strong profitability. Investors should carefully consider these metrics to make informed decisions based on risk tolerance and financial objectives.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
Asymchem Laboratories (Tianjin)	6,061.30	-0.03%	2.44%	-20.34%	0.2	0.3	35,334.41	3,137.41	52.38%	11.3X
BenevolentAI	63.50	-0.72%	4.10%	-32.89%	0.1	0.2	-13.91	-71.56	100.00%	0.2X
Biodesix	135.71	0.02%	5.52%	3.45%	0.7	0.4	175.62	-45.09	70.60%	-3.9X
Biomea Fusion	676.98	0.60%	8.28%	104.75%	1.5	-0.1	349.66	-113.81	0.00%	-3.1X
BioXcel Therapeutics	106.82	-0.34%	8.07%	-27.49%	0.0	-0.4	109.53	-200.32	55.31%	-0.5X
Black Diamond Therapeutics	122.89	0.71%	16.03%	24.61%	0.9	3.3	14.49	-86.98	0.00%	-0.2X
Bristol Myers Squibb	101,697.10	-0.13%	1.19%	-5.32%	0.5	0.4	133,765.45	18,268.00	77.01%	7.3X

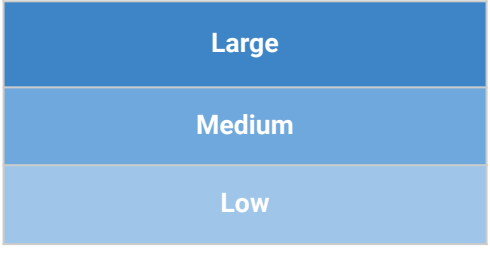
The data reveals diverse financial profiles among the listed companies. Bristol Myers Squibb, with a substantial $101,697M capitalization, exhibits a comparatively stable Mean Daily Return and low Volatility of Daily Returns. In contrast, smaller entities like BenevolentAI and BioXcel Therapeutics show negative Estimated Monthly Returns and challenges in EBITDA, potentially reflecting higher risk. The Enterprise Value to EBITDA ratios vary significantly, emphasizing differences in financial leverage and valuation across these pharmaceutical and biotech firms.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
BullFrog AI	15.97	-0.01%	9.41%	-9.66%	0.7	1.3	11.84	-4.61	92.00%	-2.6X
C4X Discovery	31.02	-0.20%	3.18%	-25.84%	0.2	0.7	14.90	-10.14	97.84%	-1.5X
Champions Oncology	67.53	0.11%	3.41%	-12.11%	0.2	0.0	70.47	-4.55	42.75%	-15.5X
Charles River Laboratories International	10,356.31	-0.01%	2.19%	11.31%	1.1	1.3	13,196.33	972.45	36.89%	13.6X
Compugen	73.75	0.18%	4.85%	15.97%	1.6	1.6	15.09	-34.01	87.00%	-0.4X
Dainippon Sumitomo Pharma	1,267.36	-0.32%	2.04%	7.41%	0.0	-0.3	316,683.35	-200,806.01	62.36%	-1.6X
Eisai	14,557.71	-0.08%	1.83%	-6.07%	0.2	0.4	-121,864.45	104,422.00	78.19%	-1.2X

BullFrog AI, with a market capitalization of $15.97M, exhibits a marginal mean daily return of -0.01% and high volatility at 9.41%. The estimated monthly return is notably negative at -9.66%, reflecting potential challenges. Additionally, the Enterprise Value (EV) to EBITDA ratio of -2.6X suggests financial strain. In contrast, Charles River Laboratories International, with a substantial capitalization of $10,356.31M, demonstrates a stable mean daily return, lower volatility, and a healthier EV/EBITDA ratio, indicating a more robust financial position.



AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
Erasca	271.96	-0.27%	4.24%	-24.37%	2.1	1.6	38.65	-142.01	0.00%	-0.3X
eTherapeutics	65.64	-0.19%	3.80%	-23.63%	0.3	0.5	27.98	-12.56	100.00%	-2.2X
Evaxion Biotech	18.70	-0.17%	6.71%	-39.65%	0.9	0.1	22.42	-24.10	0.00%	-0.9X
Everest Medicines	822.10	0.24%	6.64%	-30.16%	0.8	1.1	3,937.03	-1,194.08	63.19%	-3.3X
Evogene	42.97	0.19%	5.06%	41.67%	1.0	1.2	22.09	-20.80	71.02%	-1.1X
Evolutionary Genomics	2.99	-0.15%	2.64%	0.00%	0.0	0.0	12.02	-0.99	0.00%	-12.1X
Evotec	3,550.80	0.13%	2.96%	13.09%	1.0	1.4	1,714.65	97.33	26.78%	17.6X

Analyzing the provided data, Erasca exhibits a relatively modest capitalization of $271.96M with a negative Mean Daily Return and a high Volatility of Daily Returns, suggesting market instability. Additionally, the Estimated Monthly Return is notably negative at -24.37%. The Enterprise Value (EV) to EBITDA ratio is -0.3X, implying potential financial challenges. Conversely, Evotec, with a substantial $3,550.80M capitalization, displays positive returns, lower volatility, and a robust EV/EBITDA ratio of 17.6X, indicating a more stable financial position.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
Exscientia	803.99	0.24%	6.03%	15.95%	2.1	1.8	378.84	-165.43	-26.74%	-2.3X
Frontage Laboratories	533.90	-0.10%	2.87%	-2.83%	0.5	0.7	4,084.17	47.72	32.33%	85.6X
Gain Therapeutics	39.43	-0.05%	3.56%	-10.30%	1.1	0.9	21.34	-22.34	0.00%	-1.0X
Galapagos	2,576.38	-0.04%	1.94%	1.74%	-0.1	-0.1	-1,379.97	-139.35	11.60%	9.9X
GENFIT	159.47	-0.06%	3.26%	-0.62%	0.4	0.4	122.67	-31.45	100.00%	-3.9X
HK inno.N	859.35	0.04%	1.87%	-5.60%	0.0	0.0	1,574,334.10	119,075.56	50.03%	13.2X
Icosavax	526.95	0.25%	5.71%	47.13%	2.3	1.3	281.27	-103.19	0.00%	-2.7X

The data reveals diverse financial profiles among the listed companies. Notably, Gain Therapeutics faces negative Estimated Monthly Return and a negative EV/EBITDA ratio, indicating potential financial challenges. Frontage Laboratories exhibits a high EV/EBITDA ratio of 85.6X, suggesting overvaluation, while Exscientia demonstrates solid financials with positive metrics. Icosavax displays a considerable Estimated Monthly Return and a negative EV/EBITDA ratio, warranting attention to its risk-reward dynamics. Investors should consider these factors when evaluating investment opportunities in the biotech and pharmaceutical sector.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
IDEAYA Biosciences	1,988.58	0.30%	3.77%	6.64%	1.1	0.8	1,548.35	-116.55	0.00%	-13.3X
Ionis Pharmaceuticals	7,197.99	0.15%	2.26%	8.38%	1.2	0.5	6,307.75	-540.31	-55.94%	-11.7X
Ipsen	9,197.32	0.02%	1.47%	-7.21%	0.2	0.1	8,861.06	1,064.20	83.07%	8.3X
IQVIA	39,626.23	0.04%	1.61%	9.44%	1.1	1.2	51,751.67	2,715.00	34.88%	19.1X
ITeos Therapeutics	361.79	-0.18%	3.96%	-0.98%	1.4	0.8	-238.47	-91.19	100.00%	2.6X
Landos Biopharma	13.09	0.03%	5.03%	4.48%	0.5	0.6	-28.91	-23.10	0.00%	1.3X
Lantern Pharma	39.14	-0.12%	4.57%	23.73%	0.8	0.8	-3.78	-16.81	0.00%	0.2X

The data reveals diverse financial profiles among the listed biopharmaceutical companies. Ideaya Biosciences exhibits a substantial capitalization of $1,988.58M, while maintaining positive mean daily returns and moderate volatility. Conversely, Ionis Pharmaceuticals and IQVIA showcase higher capitalizations, yet face challenges with negative EBITDA and elevated EV/EBITDA ratios, suggesting potential financial strain. Ipsen stands out with a strong gross profit margin of 83.07%, indicating efficient cost management. These metrics offer valuable insights for investors navigating the dynamic biopharmaceutical market.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
LEXEO Therapeutics	345.37	1.60%	5.70%	33.33%	0.7	0.8	375.55	-65.48	0.00%	-5.7X
LungLife AI	25.80	0.21%	6.99%	-4.12%	0.2	-0.3	15.50	-5.93	100.00%	-2.6X
Lunit	1,758.12	0.88%	5.92%	-13.10%	-0.2	-0.1	1,835,697.18	-34,502.34	100.00%	-53.2X
Median Technologies	80.95	-0.24%	3.82%	-11.30%	0.3	0.2	73.81	-23.33	-18.60%	-3.2X
NetraMark	16.96	0.57%	7.45%	9.38%	0.9	1.8	18.48	N/A	100.00%	N/A
Neumora Therapeutics	1,829.38	-0.37%	6.60%	5.00%	1.4	0.3	1,402.32	-168.16	0.00%	-8.3X
Novo Nordisk	438,786.30	0.18%	1.94%	-2.67%	0.5	0.5	412,350.68	100,106.00	84.14%	4.1X

The provided data highlights the diverse financial landscapes of various companies. Novo Nordisk, with a substantial capitalization of $438,786.30M, exhibits stability and a strong Gross Profit Margin of 84.14%. Contrastingly, Lunit faces challenges with a negative EV/EBITDA of -53.2X, reflecting potential financial strain. Investors may consider the Mean Daily Return, Volatility, and key financial ratios for comprehensive insights into these companies' market performance and risk factors.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
Novoheart Holdings	364.83	-0.02%	1.44%	12.64%	0.1	0.1	N/A	N/A	N/A	N/A
OpGen	4.35	-0.16%	14.75%	-41.34%	-0.4	0.3	16.39	-16.95	-250.95%	-1.0X
Predictive Oncology	13.08	0.05%	8.52%	-2.72%	1.9	2.4	3.39	-13.93	70.13%	-0.2X
Recursion Pharmaceuticals	1,584.00	0.22%	7.25%	37.52%	3.0	2.2	1,297.49	-293.67	0.00%	-4.4X
Relay Therapeutics	1,127.91	-0.09%	4.75%	12.55%	2.3	1.6	392.85	-363.49	0.00%	-1.1X
Renalytix AI	19.37	-0.48%	6.13%	-58.44%	-0.3	0.1	11.87	-39.09	13.97%	-0.3X
Roivant Sciences	7,938.72	0.21%	3.94%	11.08%	1.4	0.8	7,305.08	-1,018.38	0.00%	-7.2X

The presented data reveals diverse financial landscapes among healthcare companies. Novoheart Holdings boasts a moderate capitalization of $364.83M with a promising estimated monthly return of 12.64%. In contrast, OpGen faces financial challenges with a small capitalization of $4.35M and a negative EV/EBITDA ratio, signaling potential distress. Recursion Pharmaceuticals, with a substantial capitalization of $1,584.00M, displays a unique profile, marked by high volatility and a negative gross profit margin. Investors should consider these factors for informed decision-making in the dynamic healthcare sector.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
Sangamo Therapeutics	81.56	-0.64%	5.52%	4.52%	2.3	1.5	-16.00	-90.74	-21.85%	0.2X
Schrödinger	2,062.72	0.34%	4.40%	18.62%	2.4	2.3	1,956.49	-171.02	61.11%	-11.4X
Simulations Plus	784.18	0.05%	2.27%	8.86%	0.9	1.2	676.09	14.87	80.48%	45.5X
SomaLogic	487.90	0.13%	4.85%	18.81%	0.5	0.8	-12.75	-134.86	-19.78%	0.1X
SOPHiA GENETICS	270.10	0.30%	5.80%	2.67%	-0.8	-0.9	141.72	-67.99	69.23%	-2.1X
Syntekabio	132.18	0.26%	5.56%	-4.23%	-0.3	0.0	134,375.65	-11,065.06	93.96%	-12.1X
Transcenta	199.29	0.13%	3.44%	-10.62%	0.4	0.6	1,219.49	-419.60	23.17%	-2.9X

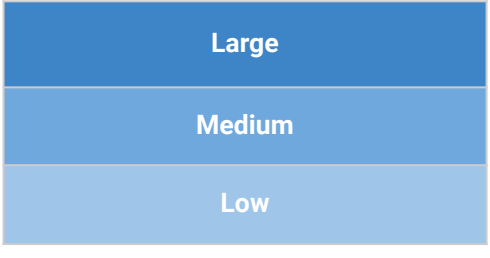
The analyzed companies showcase diverse financial performances. Schrödinger, with a substantial capitalization of $2,062.72M, boasts positive metrics, including a 61.11% gross profit margin. Simulations Plus, despite a modest capitalization of $784.18M, exhibits a high EV/EBITDA ratio of 45.5X, potentially indicating strong valuation. Conversely, Syntekabio faces challenges with a negative EV/EBITDA of -12.1X and Transcenta with a negative estimated monthly return of -10.62%, suggesting volatile market conditions or internal issues. Investors should consider these factors for a comprehensive investment strategy.

Large
Medium
Low

AI in Pharma Corporations Financials

Company	Capitalization $M	Mean Daily Return %	Volatility of Daily Returns %	Estimated Monthly Return %	IBB Beta	S&P 500 Beta	Enterprise Value (EV) $M	EBITDA $M	Gross Profit Margin %	EV/EBITDA
Veradigm	1,377.77	-0.11%	2.01%	-4.47%	0.7	0.9	1,101.79	115.35	50.64%	9.6X
Vertex Pharmaceuticals	91,201.75	0.10%	1.35%	-8.25%	0.6	0.6	80,023.46	4,570.10	61.60%	17.5X
Viva Biotech	311.83	-0.12%	3.48%	-12.31%	0.3	0.5	3,880.59	480.21	36.33%	8.1X
VolitionRx	53.98	-0.36%	5.51%	-17.35%	0.4	0.5	44.38	-34.15	100.00%	-1.3X
Wave Life Sciences	671.59	0.12%	4.09%	23.95%	1.7	1.2	375.08	-87.45	-48.57%	-4.3X
WuXi AppTec	1,377.77	-0.11%	2.01%	-4.47%	0.7	0.9	1,101.79	115.35	50.64%	9.6X

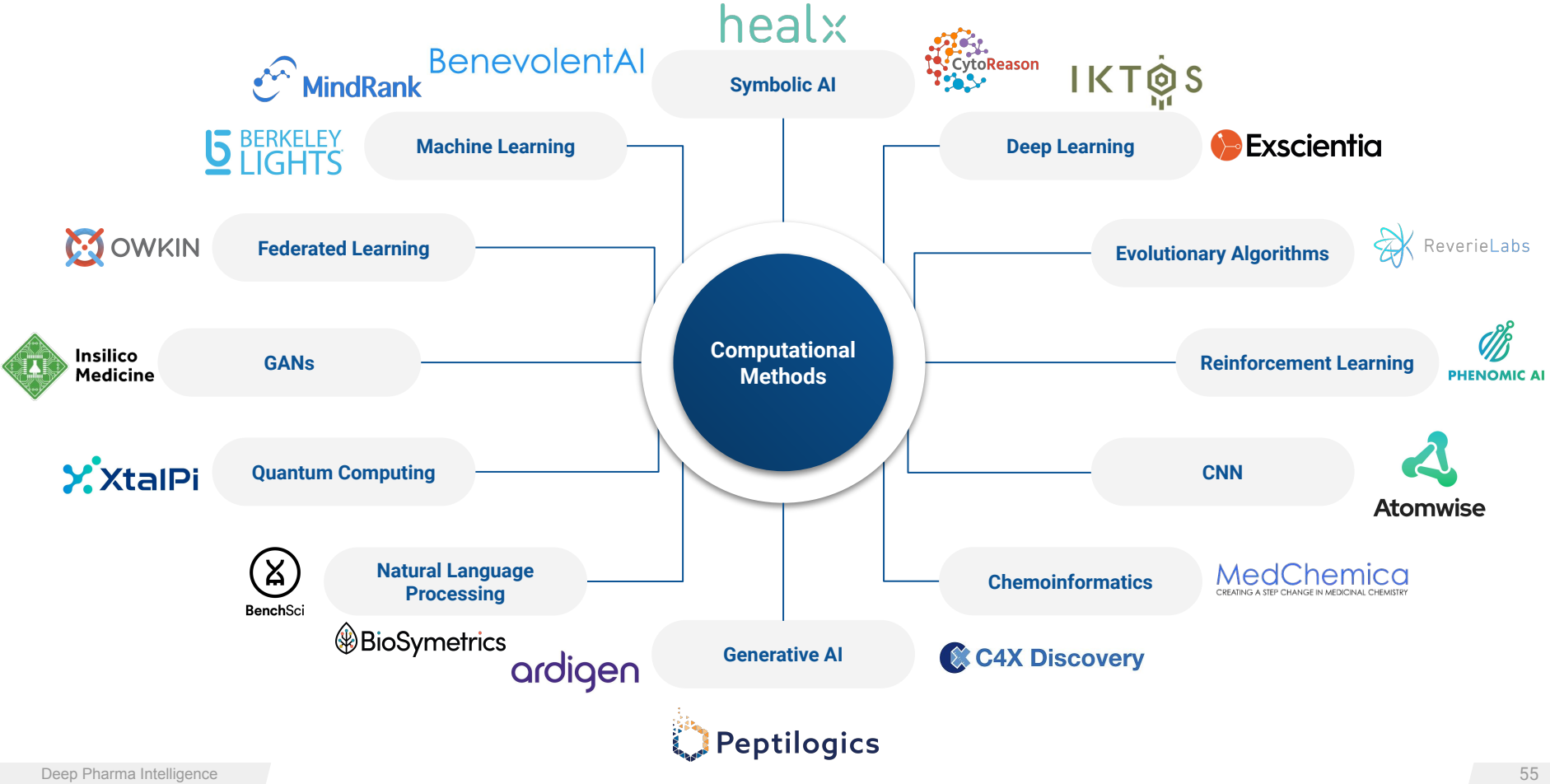
Analyzing the data, Vertex Pharmaceuticals emerges as a major player with a substantial capitalization of $91,201.75M. Despite a modest Mean Daily Return of 0.10%, Vertex shows relatively low Volatility of Daily Returns at 1.35%. However, the Estimated Monthly Return of -8.25% and a high EV/EBITDA ratio of 17.5X may raise concerns. In contrast, Viva Biotech, with a smaller capitalization, exhibits a more balanced financial profile, boasting a reasonable EV/EBITDA ratio of 8.1X and a manageable Gross Profit Margin of 36.33%.



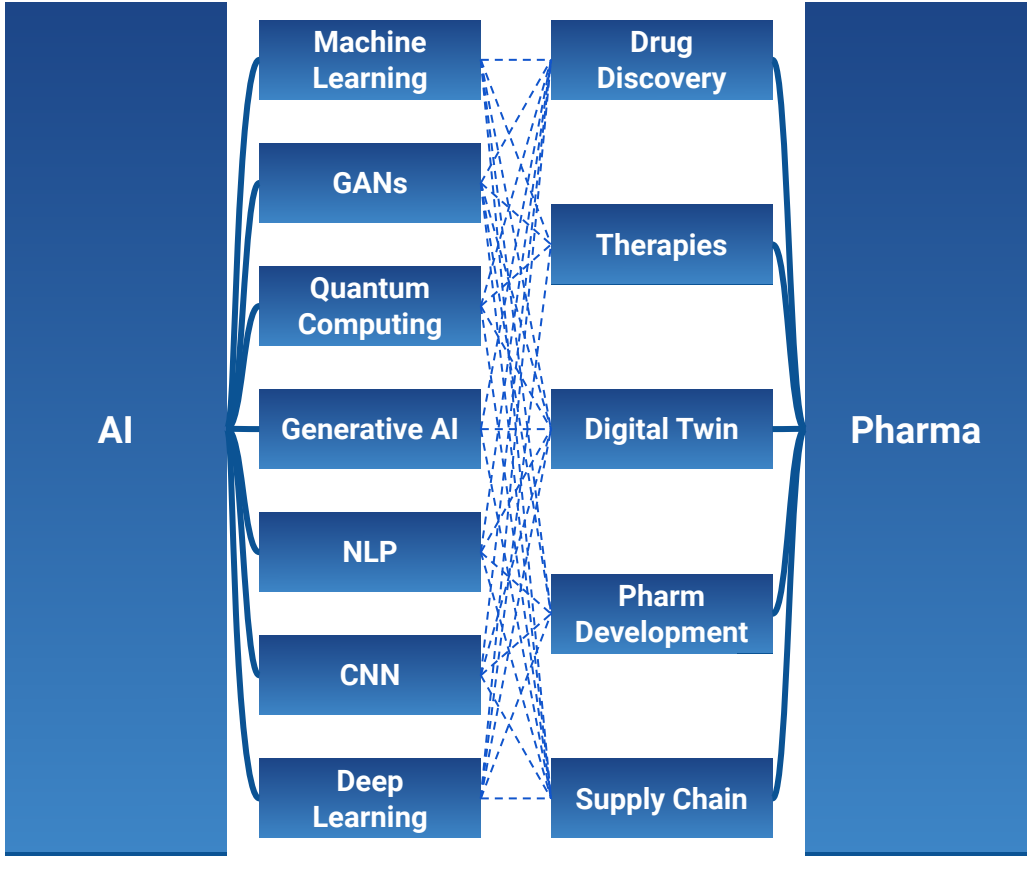
Big Pharma’s Focus on AI

Deals, Collaborations and Partnerships

Computational Methods Used by the Most Advanced AI Companies



A Growing Number of Collaborations Involving AI for Drug Discovery



In this report we have profiled **800 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, 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 an explosion of attention from leading media and consulting companies toward 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**, **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.

Selected Deals and Collaborations in AI in Pharma in 2023

The business activity has been increasing in the pharmaceutical AI space over **Q1 2023 - Q4 2023**, judging by an increased number of transactions and partnership announcements in this period.

The most significant deals and collaborations in include:

transcarent EXPERIENCE DIFFERENT 98point6	**Transcarent** to acquire part of AI-powered primary care startup **98point6**. Forbes pegged the health tech deal value at $100 million.
pvp HUMAIN DIAGNOSTICS We care for you	**PVP Ventures Limited** agreed to acquire **Humain Healthtech Pvt Ltd**. from PV Potluri Ventures Private Limited for INR 230 million on August 24, 2023.
Seagen Pfizer	**Pfizer** to acquire **Seagen** for $229 per Seagen share in cash, for a total enterprise value of approximately $43 billion.
BioMed X TWO WORLDS · ONE INSTITUTE SANOFI	**BioMed X** and **Sanofi** have entered into a research partnership to leverage artificial intelligence (AI) for drug development.
Oak St. Health CVS Health	**CVS Health** completes acquisition of **Oak Street Health**.
MERCK Prometheus Biosciences	**Merck** scoops up **Prometheus Biosciences** for $11B (April 2023).

AI and Pharma Collaborations Timeline

Jan 2022

Amgen collaborated with **Generate Biomedicines** to create protein therapeutics for five clinical targets. **Amgen** will pay potentially up to **$1.9 billion** in this collaboration for a novel AI driven platform

Feb 2022

Bayer, Aalto and **HUS** expanded collaboration to apply artificial intelligence to support clinical drug trials

Mar 2022

Elix announced a research partnership with **Shionogi** on the validating retrosynthetic analysis utilizing data from Shionogi.

Apr 2022

Takeda and **Evozyne** will create novel gene therapies for up to four rare disease targets. The deal worth up to **$400 million**

May 2022

AstraZeneca obtains a second pulmonary fibrosis target with a partnership with **BenevolentAI**

Jun 2022

Aqemia and **Sanofi** will work together on a number of initiatives in cancer, a major therapeutic area for Sanofi, to design and find new medicines.

AI and Pharma Collaborations Timeline

Jul 2022

Roche and **EarlySign** expand partnership to include AI-powered lung cancer diagnosis.

Aug 2022

Sanofi focuses on using **Atomwise's** AtomNet platform to conduct small molecule research on up to five therapeutic targets.

Sep 2022

The AI partnership between **Bayer** and **Exscientia**, which saw the two parties search for cardiovascular and cancer targets came to an end.

Oct 2022

Roche announces **PathAI** collaboration for artificial intelligence-based digital pathology applications for improved patient care.

Nov 2022

Insilico Medicine signs strategic research collaboration with **Sanofi** worth up to **$1.2B**. AI platform **Pharma.AI** will be used to advance drug development candidates for up to six new targets.

Dec 2022

Cyclica Inc and **SK Chemicals** announced an AI-driven drug discovery and development partnership to develop therapies across a range of disease areas.

AI and Pharma Collaborations Timeline

Jan 2023

Bayer and **Google Cloud** announced a joint effort to accelerate Bayer's quantum chemistry calculations to drive early drug discovery via machine learning.

Feb 2023

Tempus collaborated with **Pfizer** to use Tempus' artificial intelligence platform to advance cancer drug discovery and development.

Mar 2023

Viz.ai partnered with **Bristol Myers Squibb**. They'll use workflow software to spot patients needing more checks for hypertrophic cardiomyopathy.

Apr 2023

Merck and **XtalPi** announced a collaboration to optimizes drug formulations with AI-powered techniques.

May 2023

XtalPi announced AI drug discovery collaboration with **Eli Lilly.** XtalPi brings together AI "dry lab" algorithms and "wet lab" robotics to drive innovation.

Aug 2023

Altis Labs will lead an international project that includes drug giants **AstraZeneca** and **Bayer** to advance the use of "digital twins" in clinical trials.

AI and Pharma Collaborations Timeline

Sep 2023

Merck announced two new strategic drug discovery collaborations aimed at harnessing powerful AI-driven with **BenevolentAI** and **Exscientia**

Benevolent AI

MERCK Exscientia

Sep 2023

Israel and USA-based **Quris-AI** says that it has agreed to expand its partnership with **Merck KGaA** to predict drug toxicity in comparison to traditional approaches.

MERCK Quris.ai

Oct 2023

Owkin's AI platform will be applied to **Servier** clinical data in order to uncover insights on translational medicine and digital pathology

OWKIN

SERVIER moved by you

Oct 2023

BioMap announced a ground-breaking strategic collaboration with **Sanofi** to co-develop cutting-edge artificial intelligence (AI) modules for biologic therapies leveraging BioMap's AI platform.

sanofi

Nov 2023

Roche's Genentech has partnered with **Nvidia** in a multi-year strategic collaboration to use artificial intelligence, to accelerate drug discovery and development

NVIDIA Genentech
A Member of the Roche Group

Dec 2023

Sanofi has signed a multi-year agreement with Paris-based **Aqemia**, focused on the discovery of small-molecule drug candidates through the application of genAI and deep physics algorithms.

sanofi AQEMIA

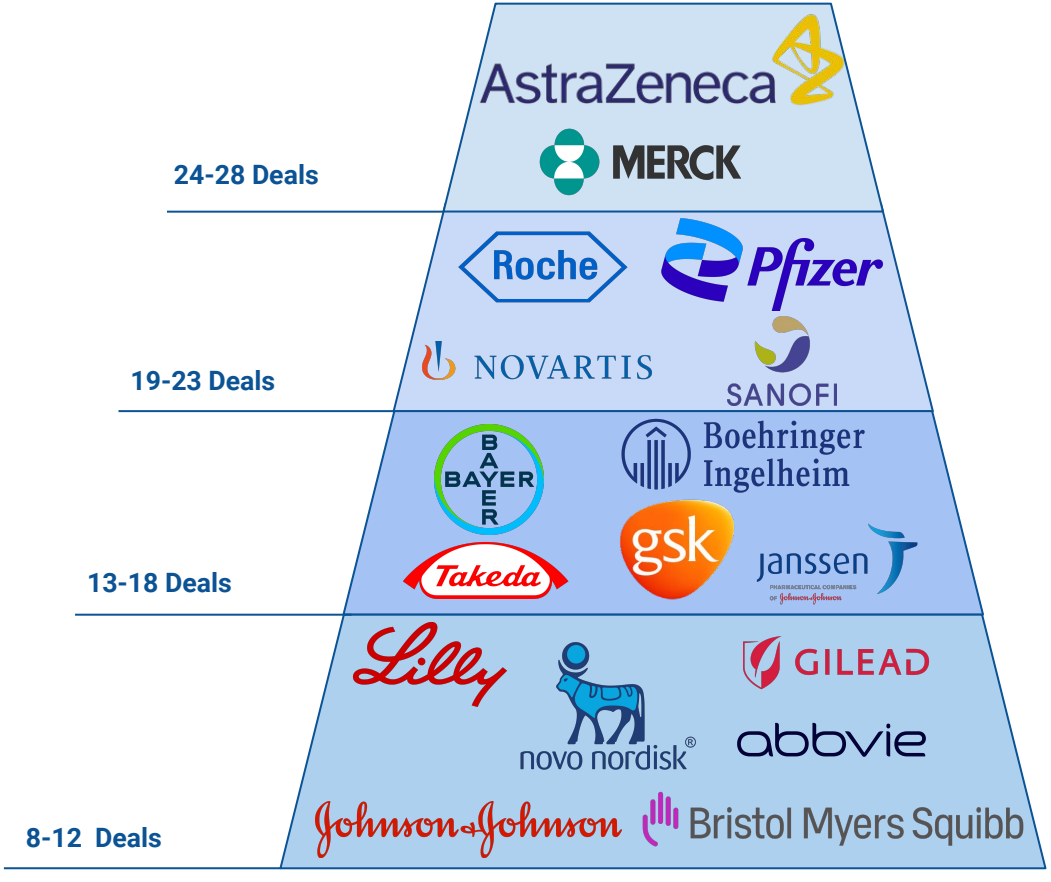
Big Pharma AI-focused partnerships

Over the past five years, the pharmaceutical industry has seen a **major shift** in top executives' attitudes towards AI technologies. Initially met with skepticism, there's now a strong recognition of AI's strategic importance in the new data-centric innovation model. This shift is driven by numerous factors:

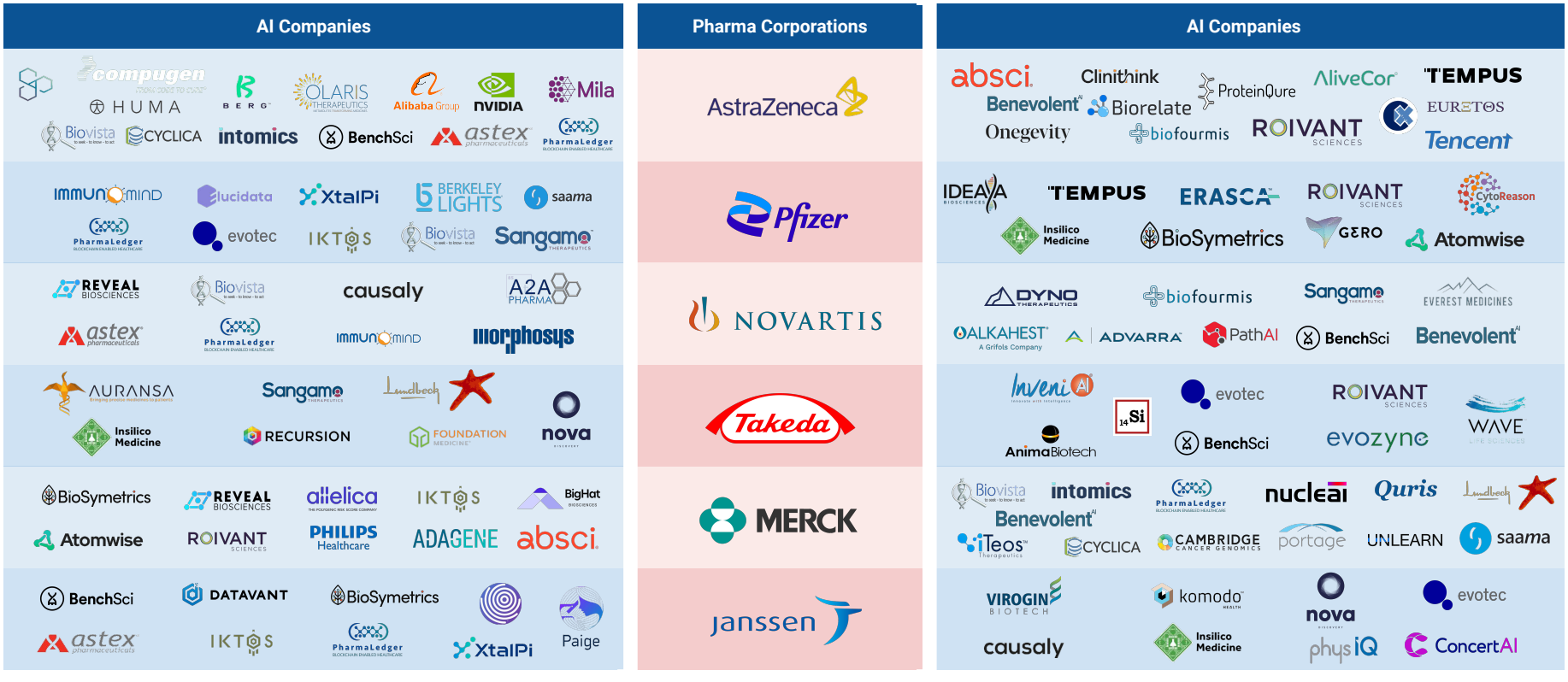
- Successful AI use case studies and research breakthroughs.
- Commercial successes where AI played a key role in research.
- Increased accessibility of AI technology, including machine learning and deep learning, for non-experts.
- Growing understanding of AI mechanics, fueled by enhanced education and professional development in AI tools.

Rising competition among pharmaceutical companies for AI expertise, talent, and partnerships.

This report highlights significant collaborations between **top-20 pharma companies**, indicating a trend towards more AI-focused drug design and data analytics collaborations.

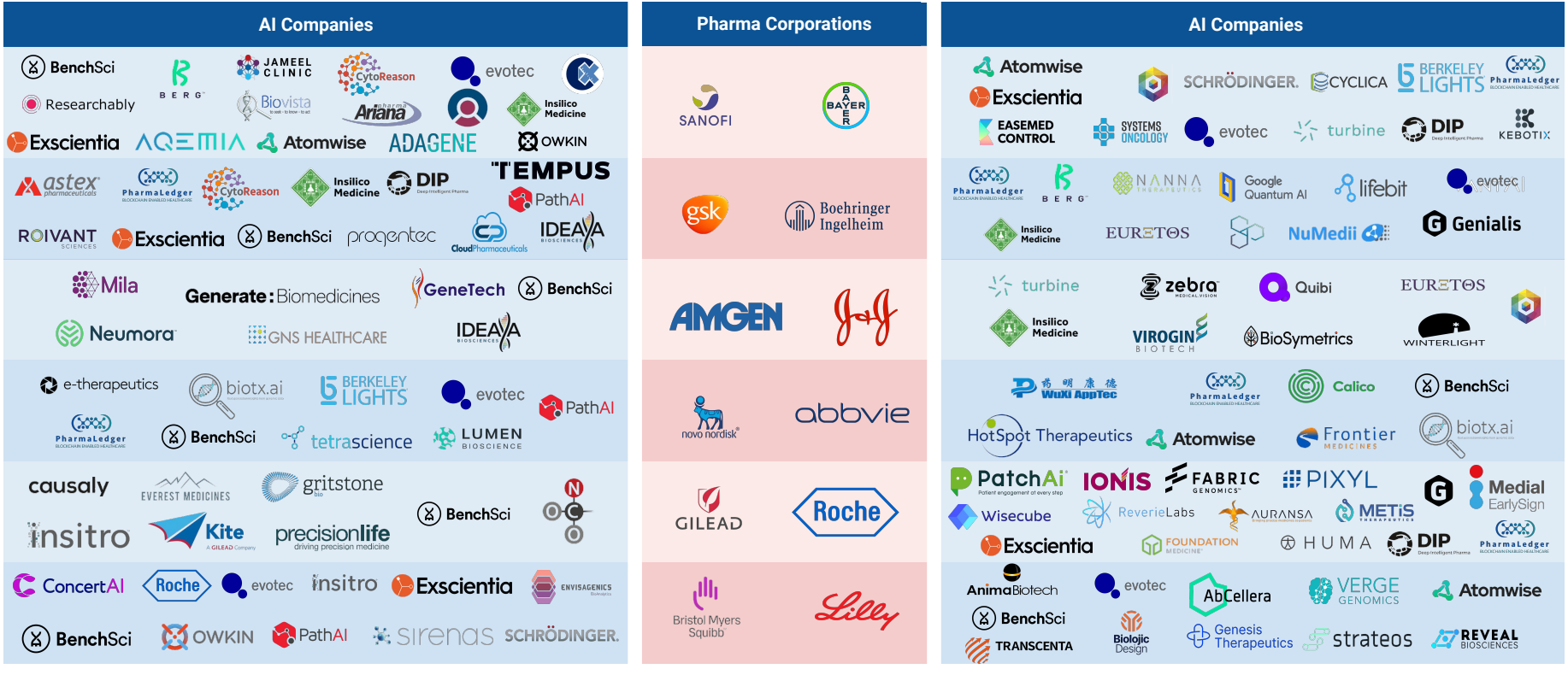


Selected Pharma AI Deals



Note: the central column (red) defines the pharmaceutical corporations and side columns (blue) defines AI companies that have collaborations with pharma companies from the central column.

Selected Pharma AI Deals



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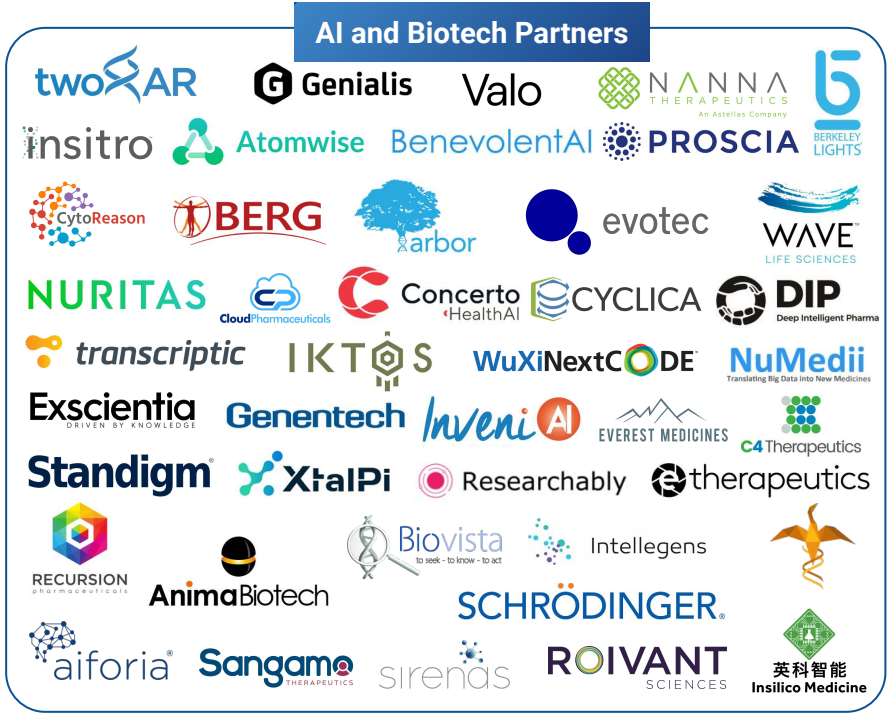
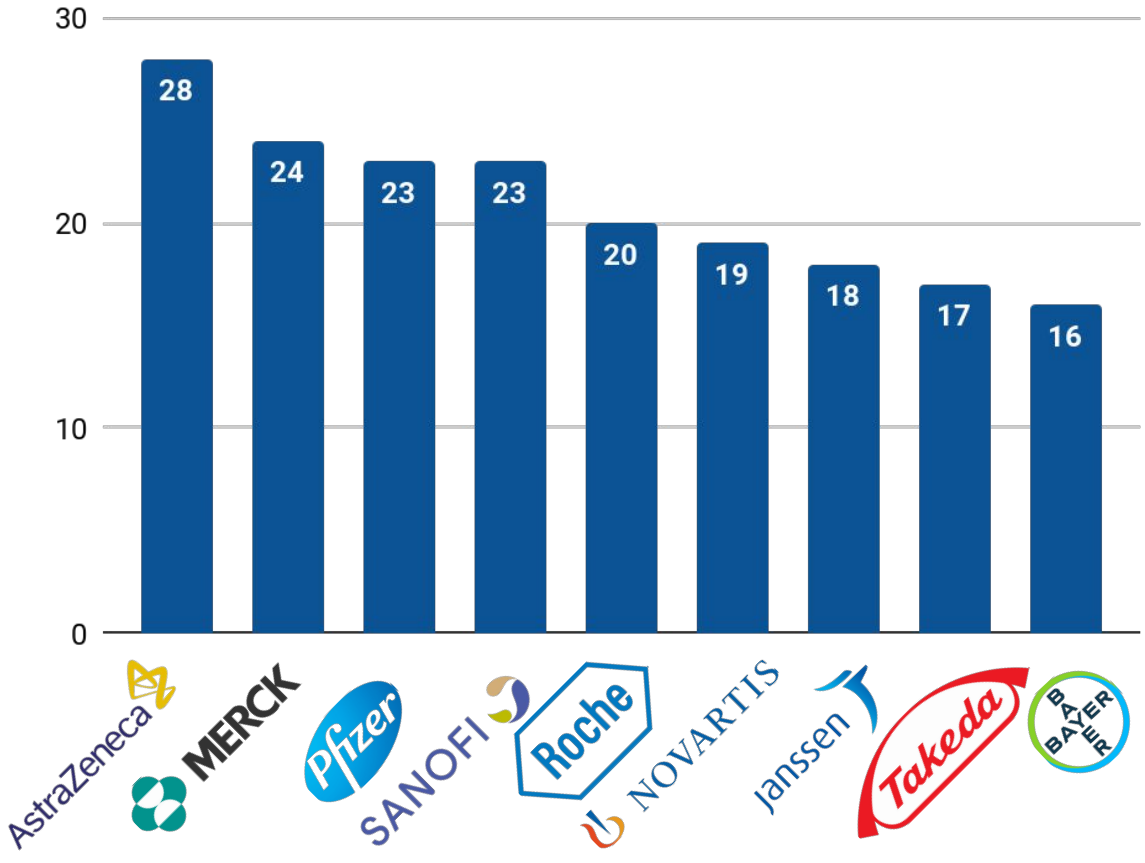
Corporation and AI-companies Participating in the Pharma AI Deals

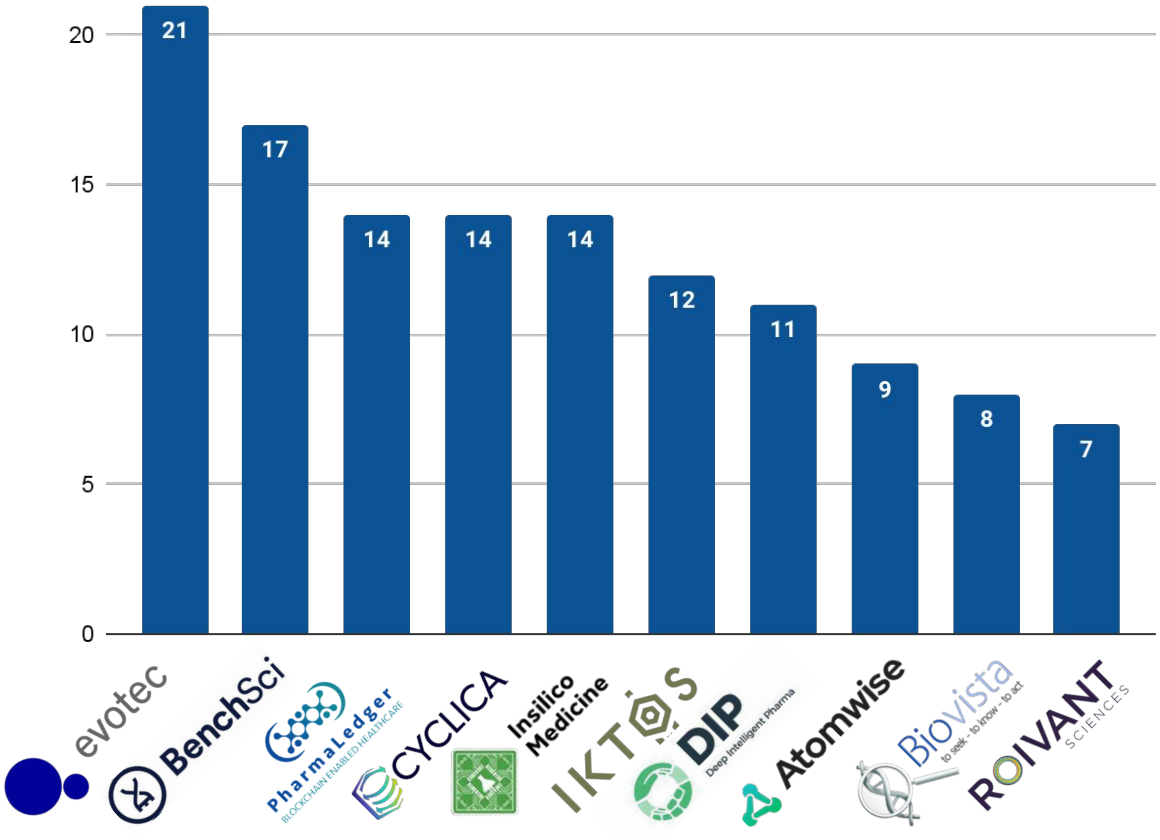


Leading Pharma Corporations by the Number of Pharma AI Deals in 2023



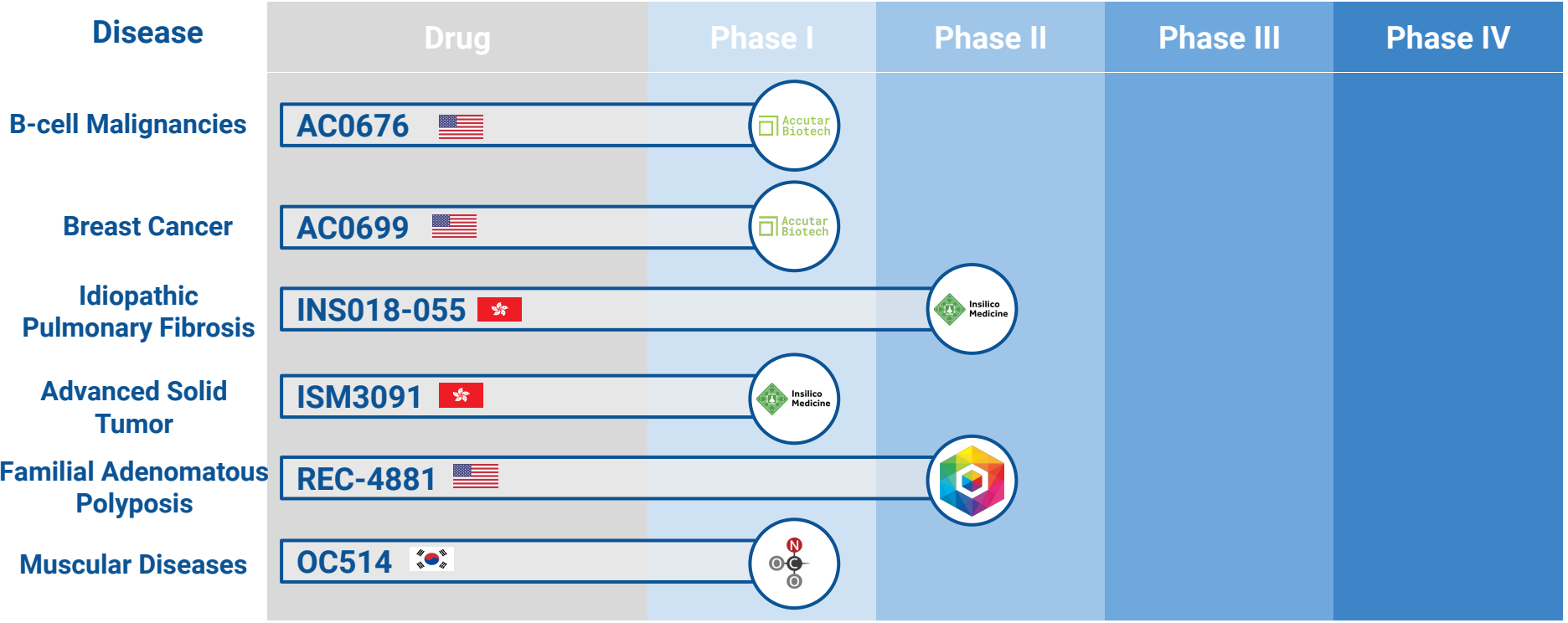
- The leading Pharma players by the amount of major industry partnerships are **AstraZeneca** and **Merck**.
- These companies demonstrate increasing commitment to probing the grounds in the AI space — by investing into internal programs, as well as partnering with external AI vendors to pilot programs 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 Number of Major Pharma AI Deals in 2023



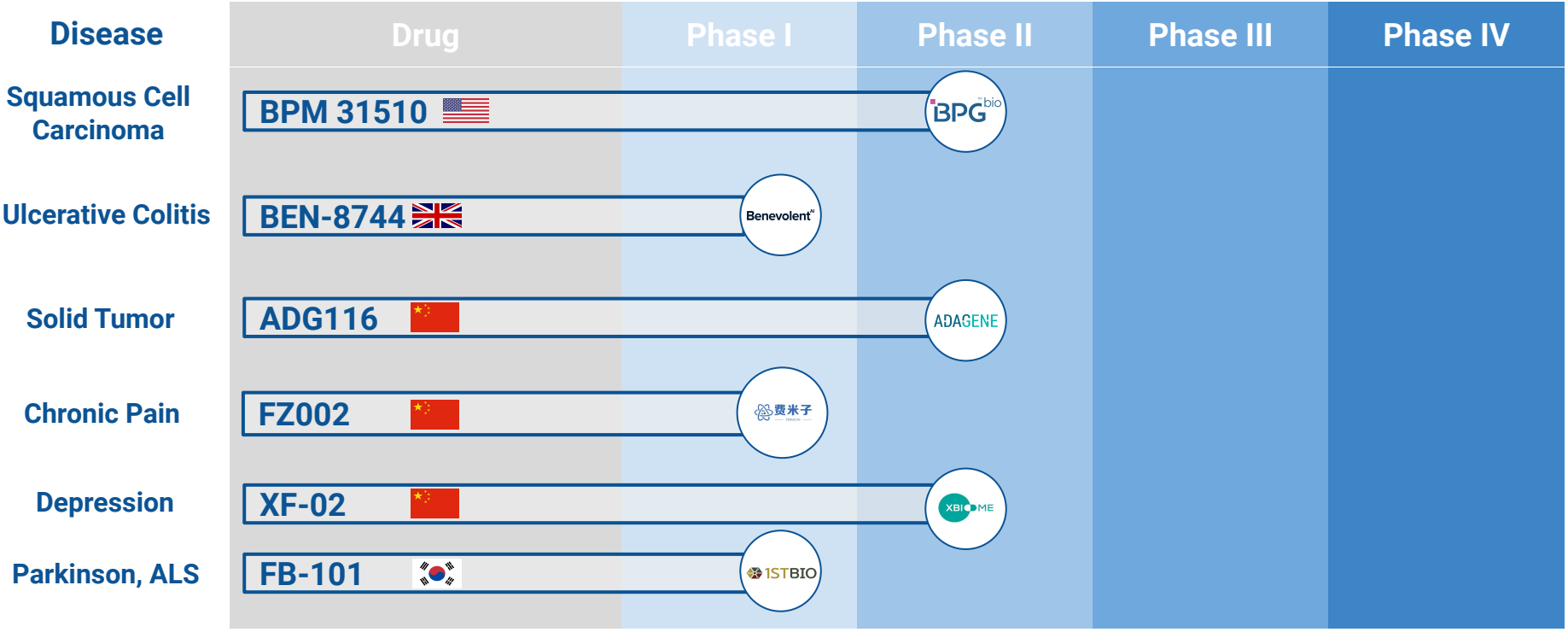
- The leading AI players by the amount of major industry partnerships are **Evotec, BenchSci, Pharmaledger, Cyclica, and Insilico Medicine.**
- **The biggest number** of AI in Drug Discovery deals were conducted by **Evotec and BenchSci.**
- The companies are **early drug development** and **end-to-end**, AI-driven pharma-technology companies that accelerate drug development by proprietary **platform across biology, chemistry and clinical development**.
- All of the deals were categorized as the ones aiming at **saving costs and increasing operational efficiency** due to the character of the services provided.

AI-Driven Drug Candidates (1/2)



Displayed above is a comprehensive update on the ongoing clinical trials pertaining to drug candidates created by end-to-end drug development companies that are powered entirely by AI technology.

AI-Driven Drug Candidates (2/2)



Displayed above is a comprehensive update on the ongoing clinical trials pertaining to drug candidates created by end-to-end drug development companies that are powered by AI technology.

Key Takeaways

Major Observations for 2023: Key Business Takeaways

AI in Pharma potential grows both quantitatively and qualitatively. Due to quickly growing proof of AI tech feasibility and innovation potential, big pharmaceutical companies and contract research organizations have been interested in collaborating with or utilizing the platforms of AI companies in the drug development process. Many companies continue to announce their collaborations in certain fields. AI-powered tools and services designed specifically for drug discovery emerge and are becoming more available.

The two industries of Big Pharma and AI Development are strengthening their collaboration with reciprocal investments. Thus, for example, in 2023, pharmaceutical company Amgen was involved in a $2.7B investment into AI-powered Generate Biomedicines, while software and hardware development company NVIDIA invested $50M in pharma company Recursion Pharmaceuticals.

More drugs developed by AI reach clinical trials. At least 5 drugs have reached Phase II in 2023. InSilico's ISM0001 is the first AI-designed drug for an AI-discovered target to reach Phase II. Dozens of drugs are viable clinical trial candidates and the list continues to expand. A similar picture can be observed with the drugs that were developed with the assistance of AI, as some of those have reached Phase III this year.

The investment landscape in the AI-powered pharmaceutical sector has shifted notably towards sector consolidation. This change is driven by Big Pharma's growing interest in AI technology, increasingly integral in research and implementation. Key examples of this trend include major investments into such companies as Bristol Myers Squibb ($4.5B), IQVIA ($1.5B), Ionis Pharmaceuticals ($500M). These investments underscore the increasing reliance of major pharmaceutical companies on AI to enhance their drug development processes.

Major Observations for 2023: Key Business Takeaways

In 2023, the average investment in AI for drug development companies decreased compared to 2022. The average investment was $48.5M last year, but it fell to $41.7M this year. This reduction occurred even though there was a significant increase in the number of investments and a record investment of $4.5B. Nonetheless, interest in AI for drug development experienced a revival this year.

In 2023, only **3 companies that use AI for DD reached IPO status**. Bullfrog AI, Neumora Therapeutics and Lexeo Therapeutics closed their IPOs and raised the total of **$358M**. It has been an improvement, as only one company reached its IPO in 2022. However, the industry still faces challenges compared to 2021, when ten companies achieved IPOs.

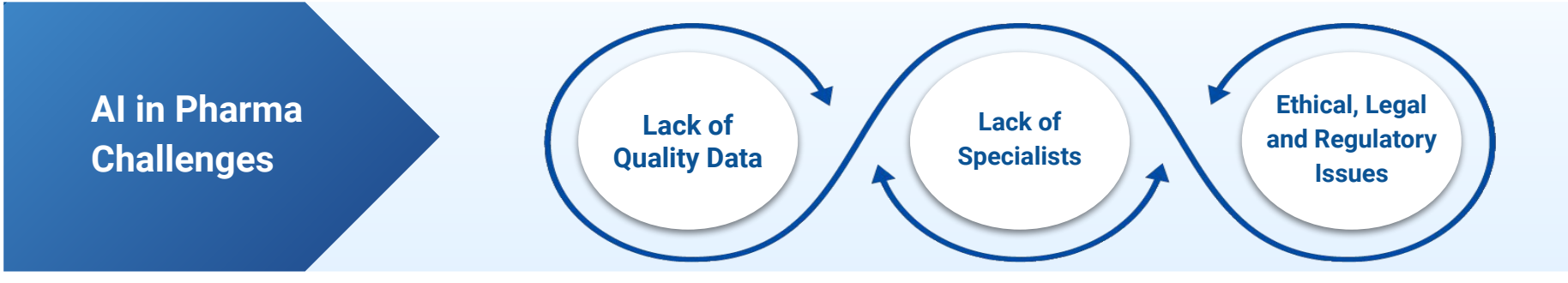
When some of the companies complete IPOs in the nearest future, it will attract a **significant number of non-biotech investors to enter the Life Sciences sector**. The prospects of this trend are already vivid: big tech companies enter partnerships with both innovative start-ups and pharma companies to consolidate resources, mainly in personalized medicine, cell and gene therapy, and molecule prediction software. Some of these companies even open subsidiaries harvesting AI in Drug Design (like Isomorphic Labs from Google).

Despite the global downturn, the AI in Drug Development sector seems to be stable. Since the start of the 2023, the cumulative capitalization of publicly traded companies increased by 19.06% and is **$809,2B of cumulative capitalization as of end of December, 2023**. However, some indices have experienced a decrease of up to 20%

Obstacles That Still Remain

There are several challenges and obstacles to the adoption of artificial intelligence (AI) in drug development. These include:

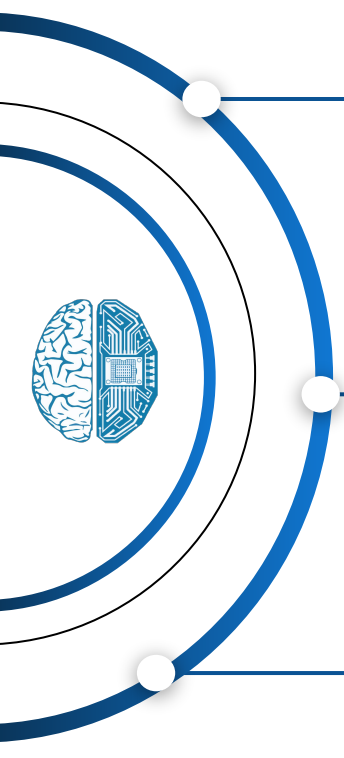
1. **Data quality and availability:** AI algorithms require large amounts of high-quality data to be effective. However, the pharmaceutical industry has historically struggled with data silos, which can make it difficult to access and integrate data from multiple sources.
2. **Regulation:** The regulatory environment for AI in drug development is still evolving. Regulators such as the US Food and Drug Administration (FDA) and the European Medicines Agency (EMA) are working to establish guidelines for the use of AI in drug development, but these are still in the early stages.
3. **Lack of understanding and expertise:** Many pharmaceutical companies and researchers may not have the necessary expertise in AI to effectively utilize it in drug development. This can make it difficult for these organizations to adopt and integrate AI into their processes.
4. **Ethical concerns:** There are also ethical concerns surrounding the use of AI in drug development, including issues related to bias in data and algorithms and the potential for AI to replace human decision-making.



Overview of
Deep Pharma Intelligence
InvestTech Advanced Solutions

About Deep Knowledge Group

Deep Knowledge Group is a consortium of commercial and nonprofit organisations active on multiple fronts in the realm of DeepTech and Frontier Technologies (AI, Longevity, FinTech, GovTech, InvestTech), ranging from scientific research to investment, entrepreneurship, analytics, media, philanthropy, and more.



Deep Knowledge Group runs several data-driven **investments and financial vehicles**

- DEEP KNOWLEDGE VENTURES
- InvestTech Platform
- LFC LONGEVITY FINANCIAL CLUB
- DeepTech and Longevity Industry Financial Advisors
- LONGEVITY CARD
- LONGEVITY CAPITAL

Deep Knowledge Group's **analytical subsidiaries** are world leaders in analytics for DeepTech and Longevity industries

- AGING ANALYTICS AGENCY
- Big Data Analytics Department
- GovTech Analytics
- FemTech Analytics
- NeuroTech Analytics
- DEEP KNOWLEDGE ANALYTICS
- SpaceTech Analytics
- DEEP PHARMA INTELLIGENCE

Deep Knowledge Philanthropy pioneers several infrastructural **social impact projects**

- DEEP KNOWLEDGE PHILANTHROPY
- 5th Industrial Revolution Institute
- LONGEVITY INTERNATIONAL
- ATLAS
- Swiss Longevity Valley
- Biogerontology Research Foundation — Prevent. Restore. Preserve.
- Philanthropy International

Explore Deep Pharma Intelligence Solutions

Deep Pharma Intelligence is building a sophisticated cloud-based engine for advanced market and business intelligence in various deeptech industries.

We provide profound AI-driven insights on the private and public markets in the Tech industries via **customized IT-Platforms and Dashboards.**

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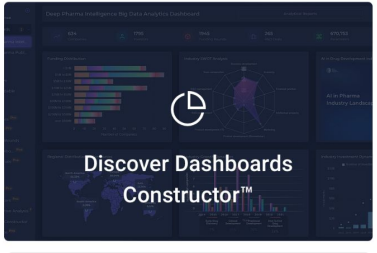
AI Industry Analytics

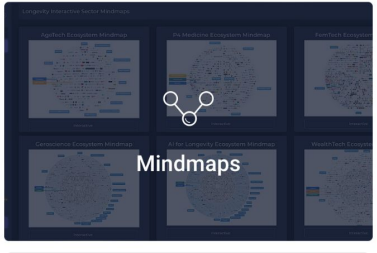
Order AI-driven research and data science reports tailored to your needs

Discover clinical trials conducted by AI for drug development companies

Get actionable insights on the flow of capital across VC, PE and M&A in the AI industry



Ultimate solutions for building customized Big Data Analytics Systems and Dashboards

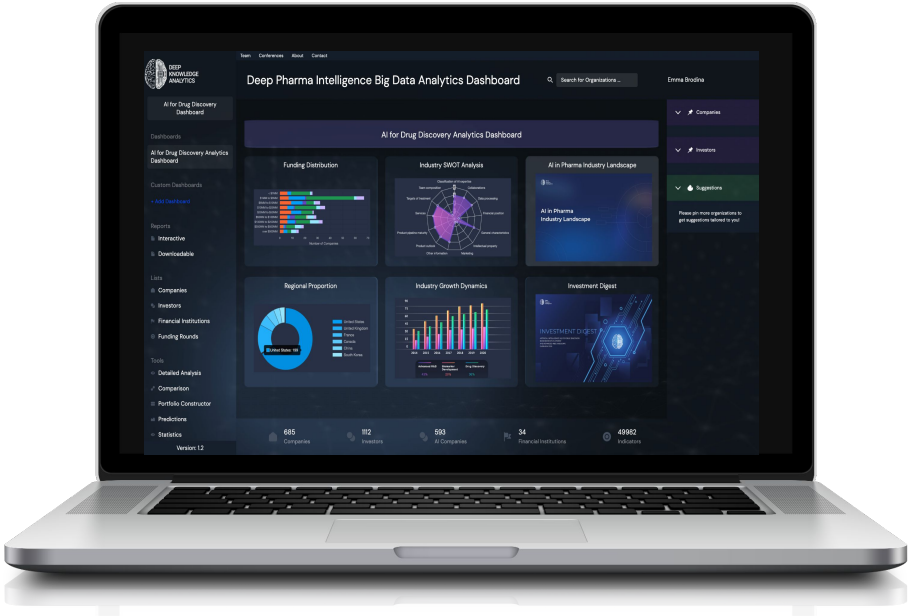


Understand the connections between companies and investors within industry sectors

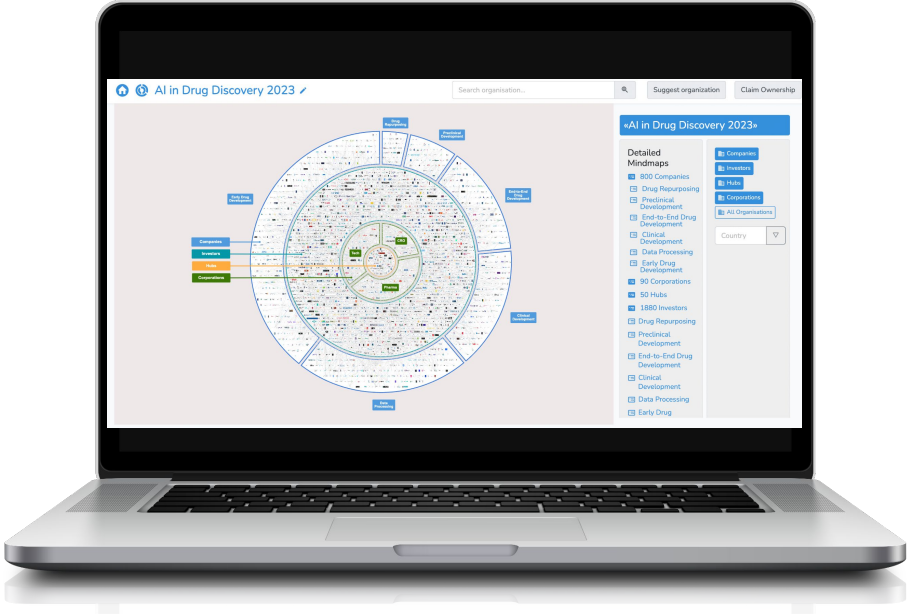
Connect to industry professionals for fruitful relationships

Explore Deep Pharma Intelligence Solutions: Examples

Big Data Analytics Dashboard



Interactive Mind Maps



www.deep-innovation.tech/pharma-dashboard

Explore Deep Pharma Intelligence Solutions: Examples

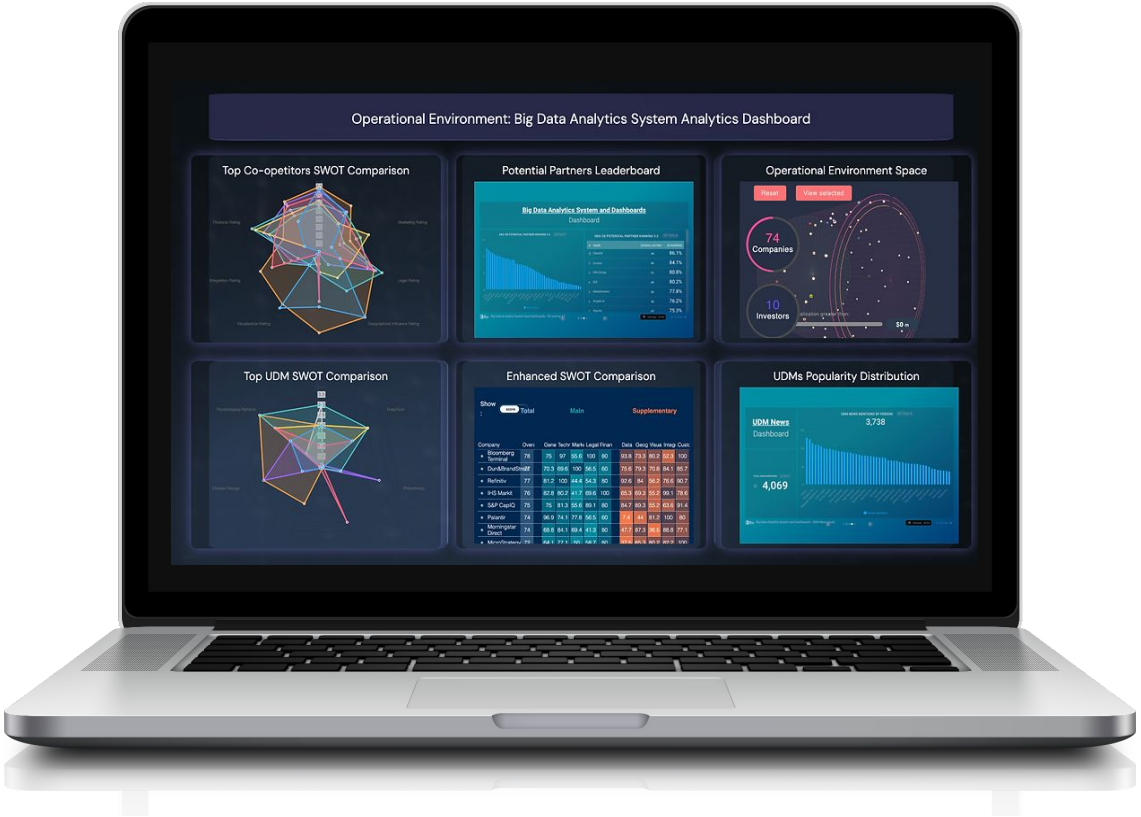
Big Data Analytics Dashboard 2.0

- 4500 AI in Biopharma Organisations
- SWOT Based on 80 Parameters
- Funding Rounds Database
- Advanced Filtering Options Based on Product Features
- Collaborations Database
- 5000 AI-assisted Clinical Trials

Coming Soon

www.deep-pharma.tech

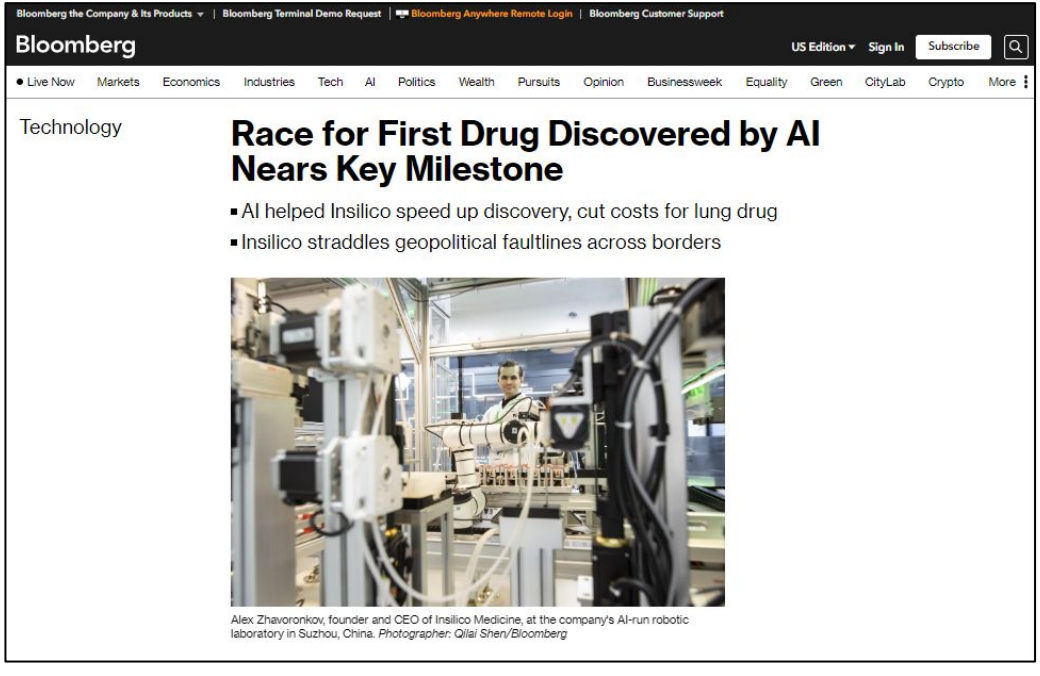
Deep Pharma Intelligence - Next Generation Market Analytics System 2.0



AI-driven Operational Environment Analysis and Smart Matching System (OE-SMS)

Explore Deep Pharma Intelligence Solutions: Examples

DPI's offerings play a key role in advancing AI within the Drug Discovery sector. A prime example is **Insilico Medicine**, which has headquarters in Hong Kong and New York, and used AI to develop an experimental drug for the incurable lung disease idiopathic pulmonary fibrosis. The treatment is in **mid-stage trials** in the US and China with some results expected early 2025.



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Technology

Race for First Drug Discovered by AI Nears Key Milestone

- AI helped Insilico speed up discovery, cut costs for lung drug
- Insilico straddles geopolitical faultlines across borders

Alex Zhavoronkov, founder and CEO of Insilico Medicine, at the company's AI-run robotic laboratory in Suzhou, China. *Photographer: Qilai Shen/Bloomberg*

DEEP PHARMA INTELLIGENCE

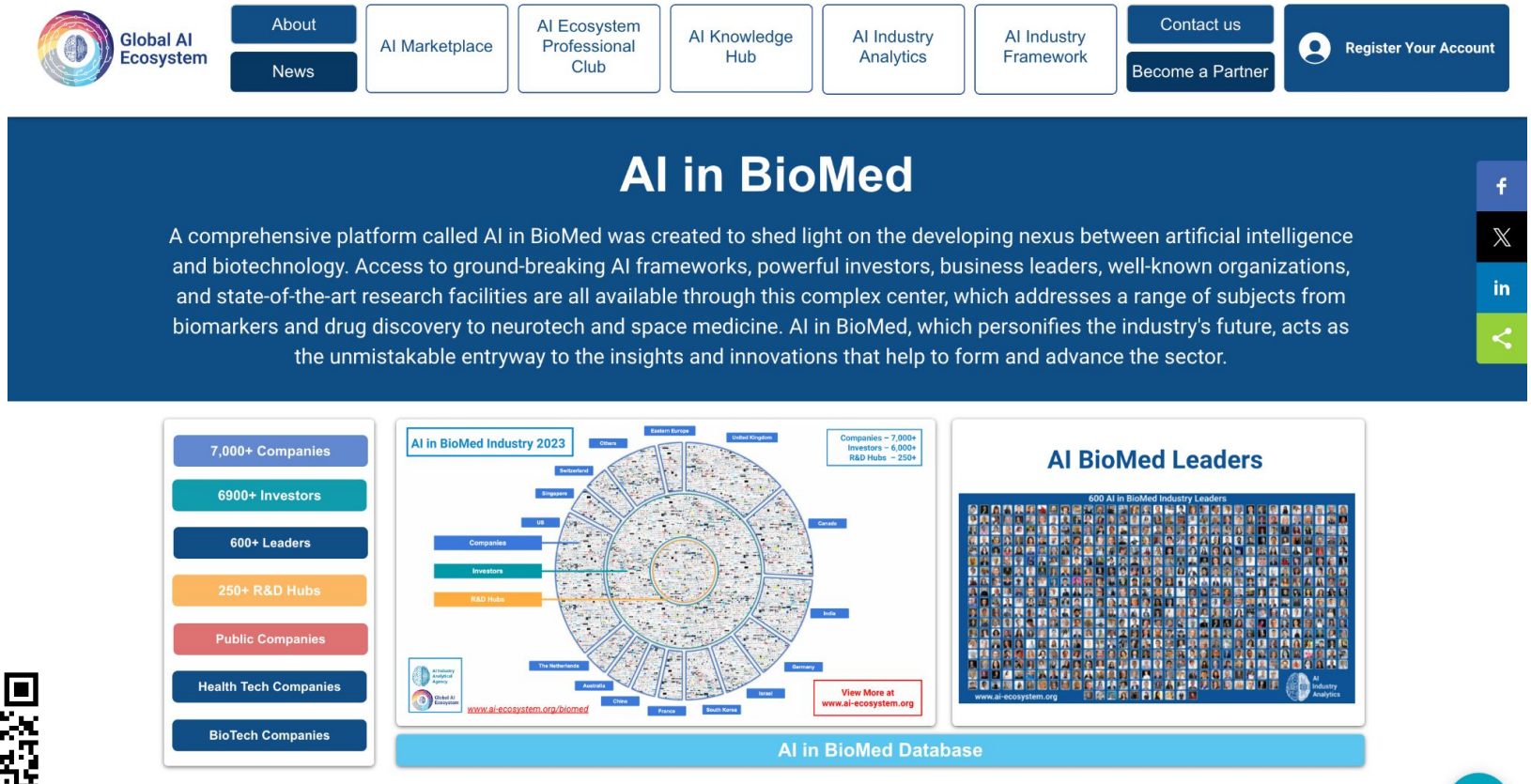
Insilico Medicine

Insilico's AI-run robotic laboratory in Suzhou, China, on Oct. 31. *Photographer: Qilai Shen/Bloomberg*

The results of Insilico's trials are being closely watched in the drug industry because the company used AI to identify a new approach to fight against the deadly disease and produce a novel molecule to treat it. UK-based researcher Deep Pharma Intelligence says that the Insilico therapy is the global industry's first fully AI-based preclinical candidate.

Source: Bloomberg

Explore Deep Pharma Intelligence Solutions: Examples



https://www.ai-ecosystem.org/biomed

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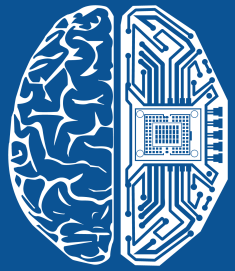

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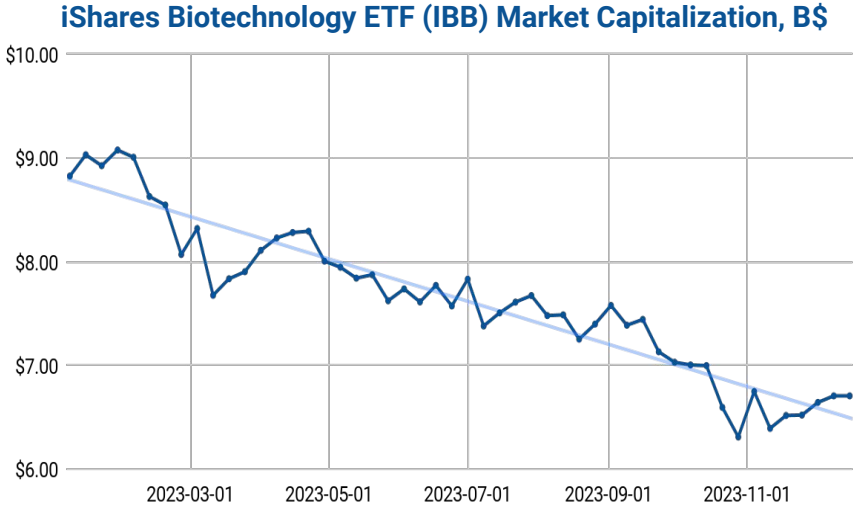
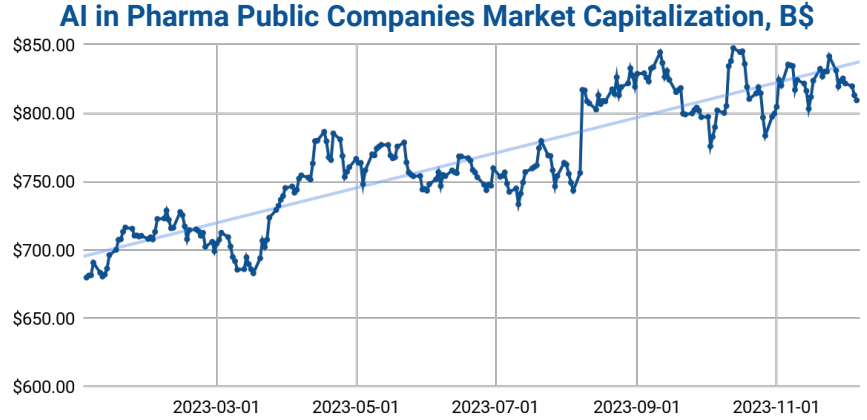
Comparison of AI in Pharma and IBB market capitalization trends



It's important to note that these trends are subject to market dynamics, regulatory changes, and other external factors. Investors should consider the inherent risks associated with both sectors and conduct further research before making investment decisions. Overall, this comparative analysis provides insights into the contrasting performances of biotechnology and **AI in Pharma**, allowing investors to make informed choices based on their risk tolerance and investment objectives.

The comparative analysis between **iShares Biotechnology ETF (IBB)** and **AI in Pharma Cumulative Capitalization** reveals interesting trends. As of December 6, 2023, IBB has shown fluctuations, ranging from **6.597 B$** to **9.078B$**. In contrast, AI in Pharma has demonstrated a consistent upward trajectory, starting at **679.646B$** on January 3, 2023, and reaching **809.184B$** by December 6, 2023. This stark difference indicates the robust growth of AI in Pharma over the specified period. Investors may find potential opportunities in the steadily advancing AI sector, while biotechnology ETFs have experienced more volatility during the same timeframe. It emphasizes the evolving landscape and investor preferences within the healthcare and technology sectors.



Key Technology Takeaways

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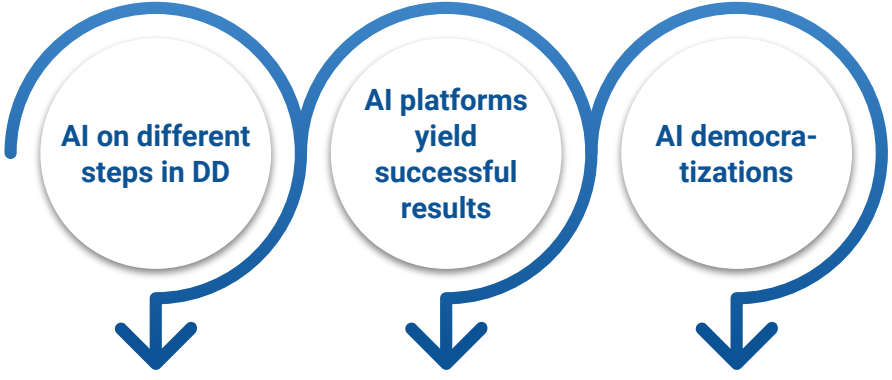
1. AI is regarded by some top executives at big pharma (**GSK and others**) as **a tool to uncover not only new molecules, but also new targets**. Ability of deep neural networks to build ontologies from multimodal data (e.g. "omics" data) is believed to be among the most disruptive areas for AI in drug 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 is used not only for drug design, but also target identification.

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

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