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Pharmaceutical Artificial Intelligence Deals And Market 2020-2021

(Teaser)

January 2021

DEEP PHARMA INTELLIGENCE

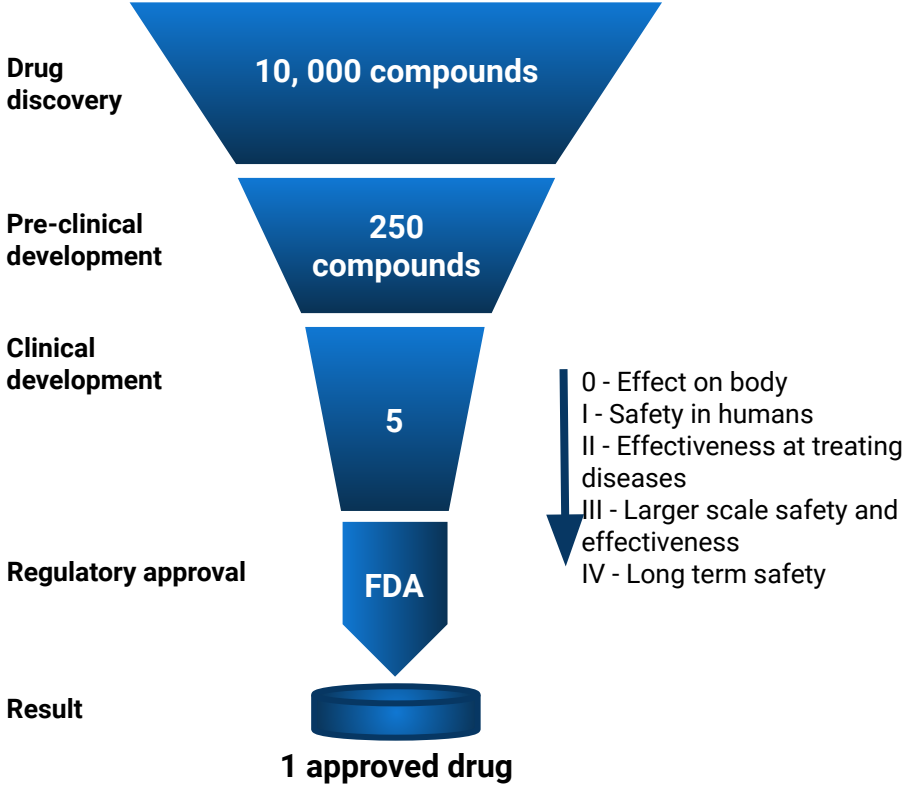
Introduction

**CROs* = *Contract Research Organizations*

Adoption of artificial intelligence (AI) technologies for a wide range of R&D problems is a rapidly growing trend in the pharmaceutical industry. This is illustrated by substantially increased amount of venture capital pouring into the AI-driven biotech companies (**above $2B in 2020 alone for drug discover, and much above that for a wider scope of biomedical and clinical applications**), the increasing number of research partnerships between leading pharma organizations and AI-biotechs/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.

There is a number of industry players actively racing for AI adoption in their R&D and business workflows, including: pharma and biotech corporations; contract research organizations, and new entrants -- global tech corporations.

Pharma Efficiency: **Challenges**



Source | Endpoints News | ePharmacology

> 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

-- development of new therapeutic modalities (biologics, therapies etc)

AI for Drug Discovery Market Timeline

The first AI approaches — 2013-2015

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

Criticism — 2016-2017

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

Market cap growth — 2018

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

Transition from quantity to quality — 2019

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

Intensive competition — 2020-2021

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

PHARMA AI STARTUPS /SCALEUPS

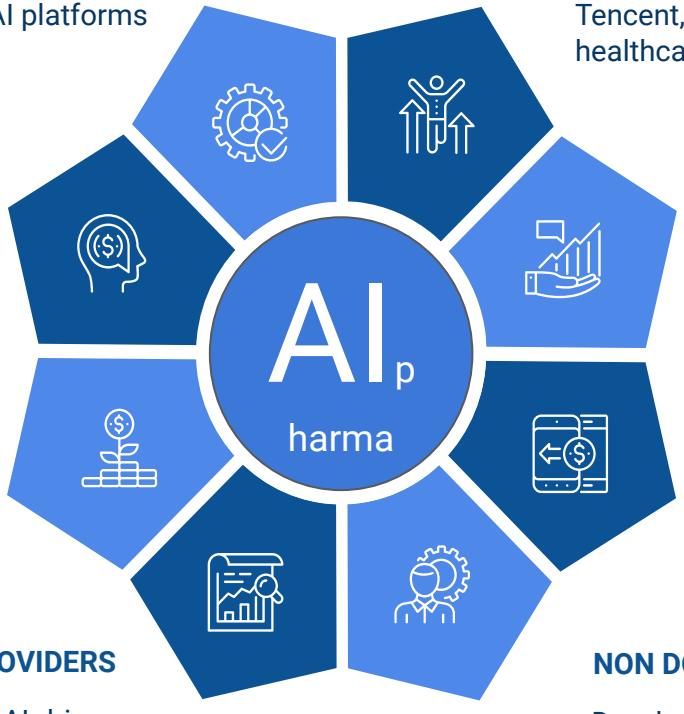
Specialized AI vendors or biotech/drug discovery startups with own AI platforms

TOP-TIER TECH COMPANIES

Top technology giants, like Google, Tencent, Amazon, rtc, actively entering healthcare space

ACADEMIC LABS

Life Science researchers creating AI tools and frameworks for the industry



PHARMA/BIOTECH CROs

CROs using AI capabilities to increase value offering for their pharma/biotech customers

TOP-TIER PHARMA/BIOTECH

Leading pharma/biotech players, like AstraZeneca, BMS, Eli Lilly, GSK, Novartis, etc

OPEN SOURCE TOOLS

Various open source tools/frameworks and other AI resources

DOMAIN-SPECIFIC IT PROVIDERS

Specialized developers of AI-driven products and services for the pharma industry

NON DOMAIN-SPECIFIC IT PROVIDERS

Developers of AI-driven products and services not specialized in pharma particularly

AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2020

AI Companies - 240
Investors - 600
Corporations - 90

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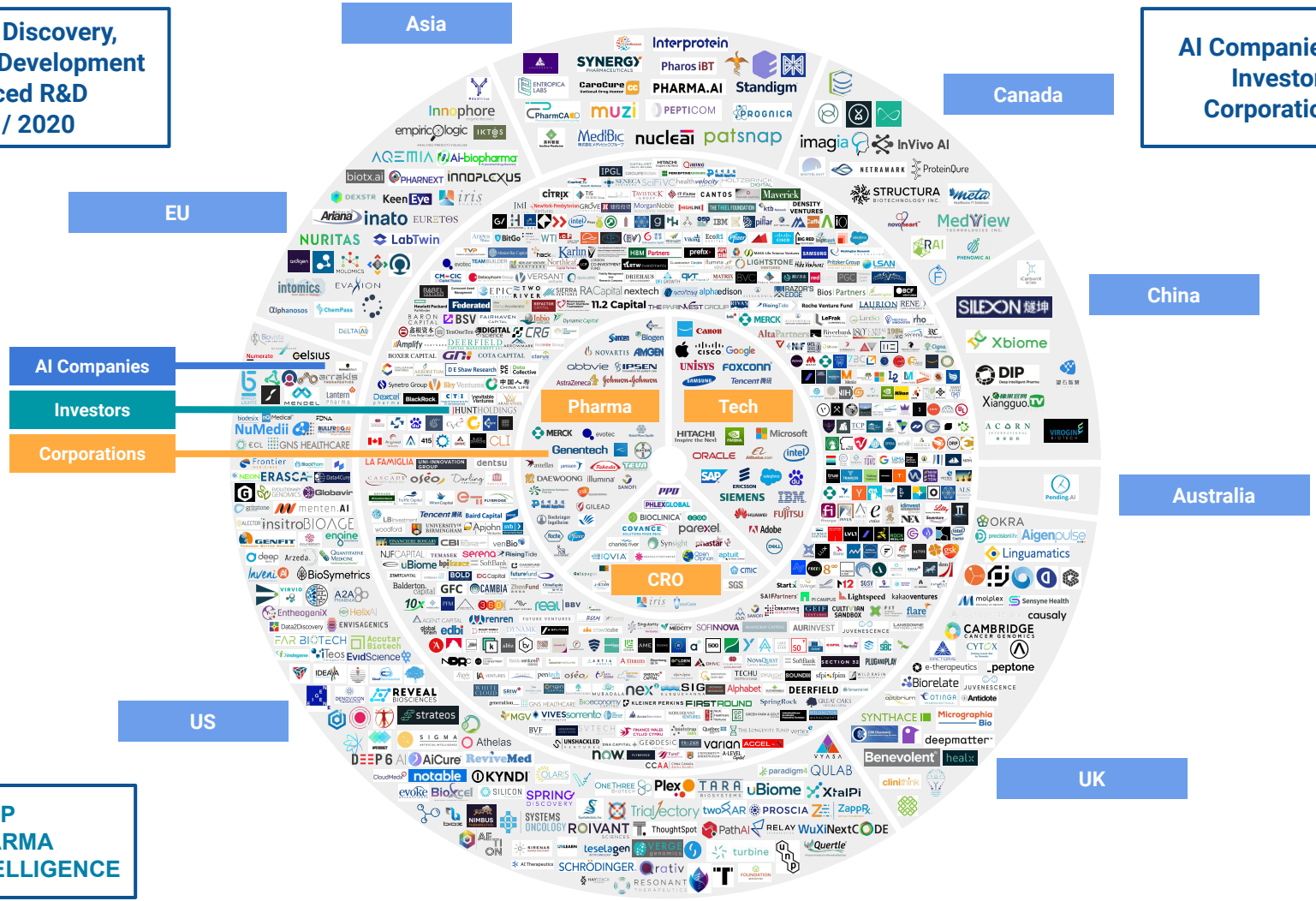

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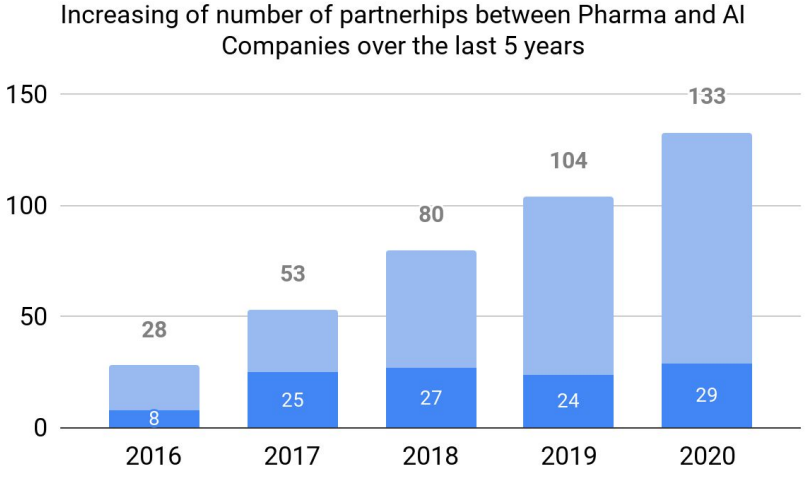
A growing number of collaborations involving AI for drug discovery

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

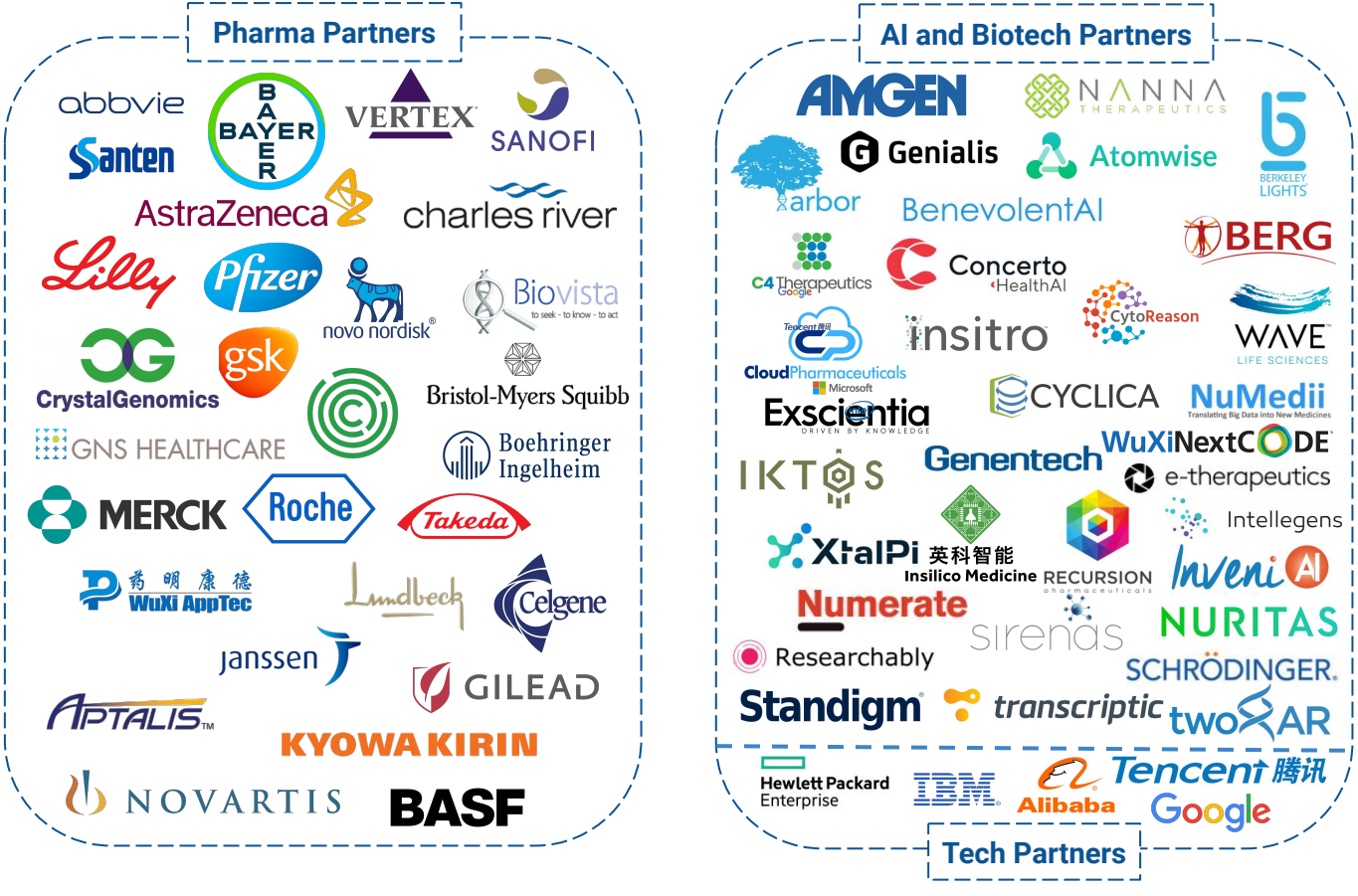
- a wave of proof-of-concept studies and research breakthroughs in a wide range of AI application use cases;
- a number of commercial successes and successfully reached milestones, involving AI as a central element of research
- substantial advances in democratizing AI technology, where machine learning and deep learning algorithms become available at scale to non-AI experts.
- substantial 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.

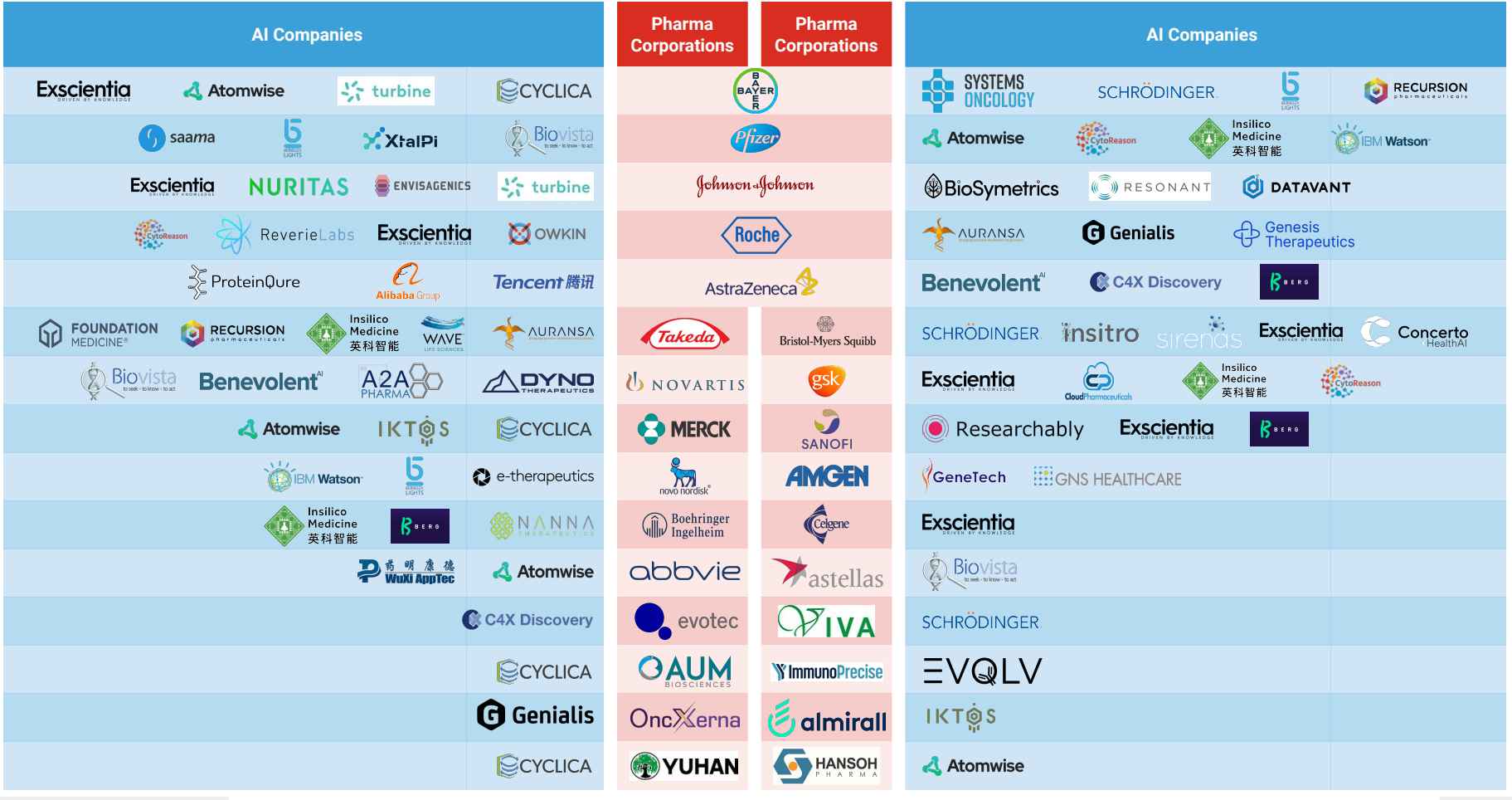


The rising interest of leading pharma and contract research organizations towards AI-driven biotech startups is a major driver for the area to become more attractive for investors, since the industry is becoming well-suited for successful exit strategies in future.

Corporation and AI-companies Participating in the Pharma AI Deals



Pharma Corporations: Leadership by AI Dealflow (R&D Collaborations)



Leading Pharma Corporations by AI Focus: R&D Collaborations, Venture Capital Deals, M&As

Pharma Corporation	R&D Collaborations with AI-companies	VC Investments	M&A Deals
Pfizer	IBM Watson, CytoReason, Atomwise, saama, XtalPi, Biovista, Insilico Medicine 英科智能, syapse	BIODESY, ADAPSYN	
Bayer	Systems Oncology, Exscientia, Schrödinger, Recursion Pharmaceuticals, Atomwise, Cyclica, turbine,	Recursion Pharmaceuticals, medopad	
Roche	CytoReason, Genialis, ReverieLabs, Exscientia, Auransa, OWKIN, Genesis Therapeutics	Black Diamond Therapeutics	flatiron
Johnson & Johnson	turbine, NURITAS, Exscientia, Envisagenics, BioSymetrics, Resonant, DATAVANT		
Bristol-Myers Squibb	Exscientia, insitro, sirenas, Concerto HealthAI, Schrödinger	Exscientia, PathAI	
AstraZeneca	Alibaba Group, ProteinQure, BERG, C4X Discovery, Benevolent AI, Tencent 腾讯		
Takeda	Auransa, Foundation Medicine, Insilico Medicine 英科智能, Recursion Pharmaceuticals, WAVE		
Novartis	Biovista, Benevolent AI, A2A Pharma, Dyno Therapeutics, QuantumBlack A McKinsey Company		
GSK	Insilico Medicine 英科智能, CloudPharmaceuticals, Exscientia, CytoReason		
Novo Nordisk	IBM Watson, e-therapeutics	Exscientia	

Leading Pharma Corporations by AI Focus: R&D Collaborations, Venture Capital Deals, M&As

Pharma Corporation	R&D Collaborations with AI-companies	VC Investments	M&A Deals
MERCK			
SANOFI			
AMGEN			
Boehringer Ingelheim			
TEVA PHARMACEUTICALS USA			
abbvie			
Lilly			
药明康德 WuXi AppTec			
Biogen			
Santen			

Leading Tech Corporations by AI Focus: R&D Collaborations, Venture Capital Deals, M&As

Tech Corporation	R&D Collaborations with AI-companies and Pharma Corporations	VC Investments	M&A Deals
Google	SCHRÖDINGER, zebiAI, Boehringer Ingelheim, SANOFI	BenchSci, XtalPi	DeepMind
Baidu 百度	MERCK	Insilico Medicine 英科智能, Atomwise, POLARIS, engine	
Tencent 腾讯	medopad, MERCK	XtalPi, Atomwise	
Lenovo	medopad	Lunit	
NVIDIA	DEARGEN, gsk		
Microsoft	DEARGEN, NOVARTIS		
IBM	Pfizer, NOVARTIS		
	NOVARTIS	COPAN	
Hewlett Packard Enterprise	Biovista		
		AI Therapeutics	

Leading Tech Corporations by AI Focus: R&D Collaborations, Venture Capital Deals, M&As

Tech Corporation	R&D Collaborations with AI-companies and Pharma Corporations	VC Investments	M&A Deals
UNISYS			
SAMSUNG			
HITACHI Inspire the Next			
Alibaba.com			
ORACLE			
ERICSSON			
salesforce			
intel			
SIEMENS			
FUJITSU			

Leading CROs by AI Focus: R&D Collaborations, Venture Capital Deals, M&As

CRO Corporation	R&D Collaborations with AI-companies and Pharma Corporations	VC Investments	M&A Deals
PPD			
BIOCLINICA			
COVANCE SOLUTIONS MADE REAL			
IQVIA			
charles river			
PRAHEALTHSCIENCES			
Galápagos			
iris PHARMA			
onsGate			
phastar			

Leading CROs by AI Focus: R&D Collaborations, Venture Capital Deals, M&As

CRO Corporation	R&D Collaborations with AI-companies and Pharma Corporations	VC Investments	M&A Deals
PHLEXGLOBAL			
CMIC			
parexel			
aptuit			
ICON			
J-STAR RESEARCH, Inc.			
SGS			
Synsight			
Open Orphan			

Select Industry Partnerships Framing the AI Sector

NOV 2020

The University of Cambridge has unveiled a five-year agreement with **AstraZeneca** and **GSK** to fund the Cambridge Centre for AI in Medicine (CCAIM). For the five-year duration, AstraZeneca and GSK will support five new PhD studentships per year. This program will enable the best and brightest young minds in machine learning and bioscience to partner with leaders in industry and academia, wherever they may be in the world.

Roche Canada launches National Artificial Intelligence Centre of Excellence to advance digital transformation in health.

OCT 2020

Takeda Pharmaceutical Company Limited, Accenture and **Amazon Web Services, Inc.** (AWS) have entered into a five-year strategic agreement to accelerate Takeda's digital transformation. Collaboration will leverage cloud and data-driven insights to accelerate drug development, increase operational agility, reduce technology costs and develop the workforce of the future.

SEP 2020

Merck Innovation Hub China announced Strategic Partnership with **Baidu Ventures**. The two parties agreed to leverage respective resources and advantages to promote innovation in artificial intelligence, healthcare, life science and other fields

NOV 2019

AstraZeneca backs $1 Billion Fund to Support China's Growing Pharma Market and establishes global research and development center in the county

Select Industry Partnerships Framing the AI Sector

OCT 2019

Novartis and **Microsoft** are joining forces to apply artificial intelligence to some of the most intractable problems in healthcare, in one of the most expansive tie-ups so far between big pharma and big tech. Under one part of the five-year agreement, which will be reviewed annually, Microsoft will work on new tools intended to make it easier to apply AI to all areas of the Swiss pharmaceutical company's business, from finance to manufacturing.

SEP 2019

GlaxoSmithKline (GSK) has opened a £10m research hub in King's Cross, London to leverage artificial intelligence (AI) for the discovery of new drugs to treat cancer and other diseases.

JUN 2019

Machine Learning Ledger Orchestration of Drug Discovery (**MELLODDY**) project: Ten large pharmaceutical companies, including **Johnson & Johnson, AstraZeneca** and **GSK**, are embarking on the first collaboration to train their drug-discovery, machine-learning algorithms on each other's data. Owkin, a Google Ventures-backed start-up based in New York and Paris, has developed a secure, blockchain-based system that allows an algorithm to trawl competitors' data with full traceability — but crucially, without revealing commercial secrets to rivals.

Google and **Sanofi** are partnering to set up a new virtual Innovation Lab with a focus on data technologies and digital health. The goal is to change how Sanofi develops new drugs. It will have three key objectives: better understand patients and diseases, increase Sanofi's operational efficiency and improve Sanofi's patient and customer experience.

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Sample Case Study

Leadership in AI Adoption:
BAYER

AI Partnerships and Programs at Bayer

Bayer is among leaders in the “artificial intelligence race”, exploring opportunities through multiple external collaborations, investments, joint projects and internal R&D programs focused on the adoption of machine learning (ML) and deep learning (DL) for drug design, diagnostics, pharmacovigilance, and crop protection research.

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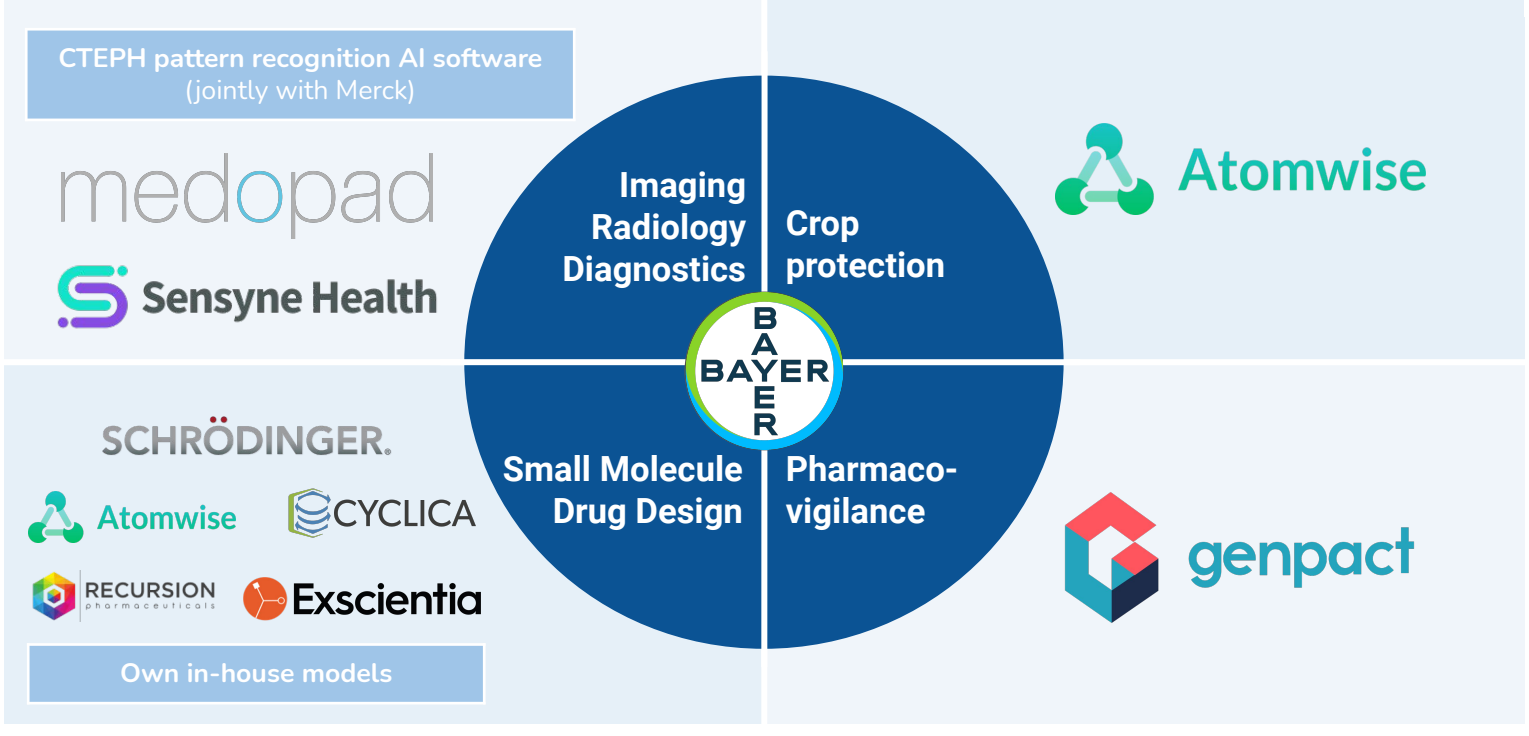

Notable Bayer's AI-related Business Activity

September 2020: Recursion Pharmaceuticals raises $239M in series D funding round. This includes $50 million from **Bayer**'s investment arm **Leaps.** Recursion has also entered drug discovery R&D partnership with Bayer -- up to $100M.

January 2020: Bayer taps **Exscientia** for a 3-year $266 million agreement to leverage AI to accelerate the discovery of small molecules candidates programs for oncology and cardiovascular diseases.

January 2020: Bayer partners with **Schrödinger** for a 5-year agreement to work on a new virtual platform for small molecules design, which will be able to design and screen synthetically feasible compounds

January 2020: Bayer exercises right to enter into follow-on research and collaboration option agreement with **Atomwise** to continue crop protection development programs using AI-driven screening platform.

July 2019: Bayer and **Sensyne Health** are collaborating to develop treatments for cardiovascular disease. Sensyne has a unique partnership with the NHS to leverage its electronic patient record data while protecting patient privacy. The partners also established the "LifeHub" project, focused on AI-enabled radiology and imaging.

November 2018: Genpact partnered with Bayer to apply AI to pharmacovigilance. Genpact's technology automatically extracts adverse event data from source documents.

September 2017: Bayer taps **Berkeley Lights** for the innovation and acceleration of cell line development, antibody discovery, and research using Berkeley Lights' AI-enabled Beacon platform to automate biological workflows and gain efficiencies in its drug development process.

Participation in the AI-focused consortia and projects

Machine Learning Ledger Orchestration for Drug Discovery (MELLODDY):

Bayer is a member of the MELLODDY project, aimed at developing a new paradigm of working with data from various parties and edge devices in a secure format -- via federated learning architecture. This allows utilizing common knowledge from diverse datasets without compromising know-hows, commercial secrets, and IP rights.
(MELLODDY | IMI Innovative Medicines Initiative)

Machine Learning for Pharmaceutical Discovery and Synthesis Consortium (MLDPS):

Bayer is a member of MLDPS, a global effort, jointly with MIT, to develop software for automating small molecule discovery and synthesis.
(Applying machine learning to challenges in the pharmaceutical industry)

Alliance of Artificial Intelligence in Healthcare (AAIH):

Bayer is a member of AAIH, the global advocacy organization dedicated to the discovery, development and delivery of better solutions to improve patient lives.
(Current members)

Bayer's AI-related investments and initiatives

Bayers' Investment Arm	Accelerator Program (G4A)	LifeHub UK
Bayer joins $25M investment in data-driven digital health startup Medopad, an artificial intelligence startup using data from provider databases and patient devices for remote disease monitoring, raised $25 million in a Series B funding round led by Bayer's life sciences innovation arm. **Recursion Pharma nets $239M, plus an AI research contract with Bayer** Bayer took the lead role in the artificial intelligence company's series D round, bestowing $50 million through its equity investment arm Leaps. The brought the round to a total of $239M. Recursion also entered in drug discovery collaboration with Bayer for up to $100M.	G4A is a global program within Bayer that "supports startups and companies that are developing innovative solutions in health and care, focused on AI and digital tech. **Cyclica, Agamon** In 2018 AI-driven startup Cyclica joined Bayer G4A as one of six finalists selected from over 1800 applicants globally. The company develops AI-based first-in-class-proteome screening technology, among other drug design tools. Later Bayer partnered with Cyclica to apply its AI technology for polypharmacology drug design. Agamon is another company in G4A, building AI-based clinical data intelligence platform.	In 2019 Bayer launches LifeHub UK focused on Artificial Intelligence to optimize data-driven drug discovery and disease diagnosis. **Sensyne Health** The first LifeHub UK's project focused on the development of AI-enabled radiology solutions using Sensyne Health's proprietary clinical AI technology platform to identify digital solutions for automated image evaluation. The project will analyse research from three million anonymised, ethically sourced NHS patient records and imaging data provided through Sensyne Health's partnerships with NHS trusts, developing digital solutions to help radiologists improve the quality of the diagnosis.

Bayer's in-house AI program

Bayer's *in silico* ADMET platform: a journey of machine learning over the past two decades

Bayer has been developing its *in silico* absorption, distribution, metabolism, and excretion (ADMET) platform for around 20 years. The platform includes various components of AI, including statistical, machine learning, and deep learning modules.

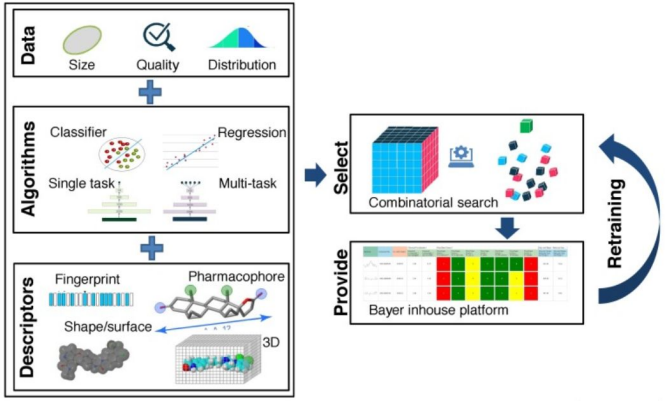

Image credit: ScienceDirect

Artificial intelligence software for CTEPH pattern recognition (Bayer, Merck)

In 2018 FDA granted Breakthrough Device Designation to the Artificial Intelligence Software for Chronic Thromboembolic Pulmonary Hypertension (CTEPH) Pattern Recognition, which Bayer developed jointly with MSD (Merck & Co., Inc.,)

Image credit: HealthImaging

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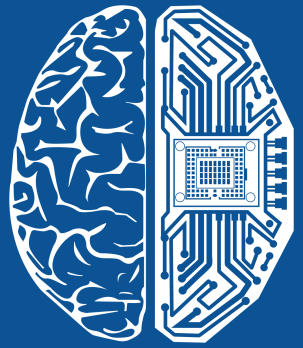

Link to the Report: www.analytics.deep-pharma.tech/Pharmaceutical-AI-Deals.pdf

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