Understanding the company landscape in AI-driven biopharma R&D

The potential of companies developing artificial intelligence (AI)-based tools for drug discovery and development has driven investment and deals with major biopharma companies, but challenges for AI biotechs and biopharma companies are emerging as the field moves beyond the hype towards impact.

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Advances in artificial intelligence (AI), coupled with greater availability of biomedical data, are revolutionizing drug discovery and development. From an initial focus on areas such as small-molecule drug design and literature analysis for target identification, AI tools are now being developed for all stages of the research and development (R&D) pipeline and for multiple therapeutic modalities. Breakthroughs such as AlphaFold2 for protein-structure prediction are adding momentum to the field, and progress with foundational models is unlocking new possibilities across data domains including images, text, '-omics' and chemistry.

Consequently, AI-based tools are currently seen by the biopharma industry as one of the key 'engines' for discovering and developing innovative drugs. To build capabilities in the field, major biopharma companies are pursuing three avenues, often in parallel.

First, companies are establishing AI expertise in-house, including through partnerships with information technology companies. For example, in 2019, Novartis and Microsoft announced a multi-year partnership to harness Novartis' datasets and Microsoft's AI tools in the discovery, development and commercialization of new medicines, and established an AI innovation lab to support researchers across the company.

Second, companies are rapidly gaining capabilities through acquisitions of AI-driven biotech companies, typically those with a focus on developing AI tools and datasets that are relevant to specific aspects of the drug R&D process. Examples of deals of this type include Genentech/Roche's 2021 acquisition of Prescient Design—a start-up specializing in using generative models for antibody design—for an undisclosed sum; and BioNTech's recently announced acquisition of InstaDeep—a company harnessing deep learning and reinforcement learning for applications such as protein design—for £362 million in upfront cash, with milestones of up to £200 million. These deals usually provide biopharma companies with both expertise from employees with bioinformatics, data science and engineering capabilities, and access to proprietary datasets such as imaging data and/or platforms.

Third, biopharma companies are establishing partnerships with AI-driven biotech companies to identify and co-develop drug candidates. Among the deals of this type with the highest headline value in recent years is a collaboration announced in December 2021 between Recursion Pharmaceuticals and Genentech/Roche to use Recursion's AI-guided high-content screening platform to identify novel targets and medicines in neuroscience and oncology. Recursion received an upfront payment of $150 million, and the potential milestone payments—$300 million each for up to 40 research programs—could reach $12 billion. In another large deal, made a month later, Exscientia partnered with Sanofi to develop up to 15 drug candidates in oncology and immunology using Exscientia's AI-based personalized medicine platform. Exscientia received an upfront payment of $100 million, and the potential milestone payments could total $5.2 billion.

AI-driven biotech companies clearly now have a prominent position in the application of AI across the industry. To gain insights into the evolution of the landscape for such companies, we analyzed the number of companies founded—segmented based on their focus on drug discovery research only, drug development only or a combination of both—as well as capital deployment in the area since 2010 (Box 1).

Box 1 | Analysis of the landscape for AI-driven biotech companies

Companies working on artificial intelligence (AI)-driven applications for drug discovery research and/or clinical development—referred to in the article as "AI-driven biotech companies"—were identified by searching PitchBook using combined keyword search terms, such as 'AI' and 'drug discovery' for research, and 'AI' and 'drug development', 'clinical trial', 'patient identification', 'lifecycle management' or 'patient data records' for development, augmented with a manual press search. All searches were conducted during the first fiscal quarter (Q1) of 2023. In addition, direct competitors to companies were identified and included. The analysis set was finalized by the manual screening of the addressability of use-cases using company websites, excluding companies that have gone out of business or with no historical fundraising data available, and a founding year before 2010.

Company capitalization analysis over time was conducted using source data from PitchBook up to 2021 (full data for 2022 were not available at the time of analysis), with subsequent categorization into several groups based on investment maturity across the following stages: seed and pre-seed, early-stage venture capital (VC), late-stage VC, private equity, corporate/strategic merger and acquisition, debt, and initial public offerings (IPOs)/public investment, including private investments in public equity (PIPEs).

Deals were identified through a search of selected companies within the IQVIA Pharma Deals dataset, and supplemented with a manual search of company websites. Data have not been reviewed by PitchBook or IQVIA Pharma Deals analysts.

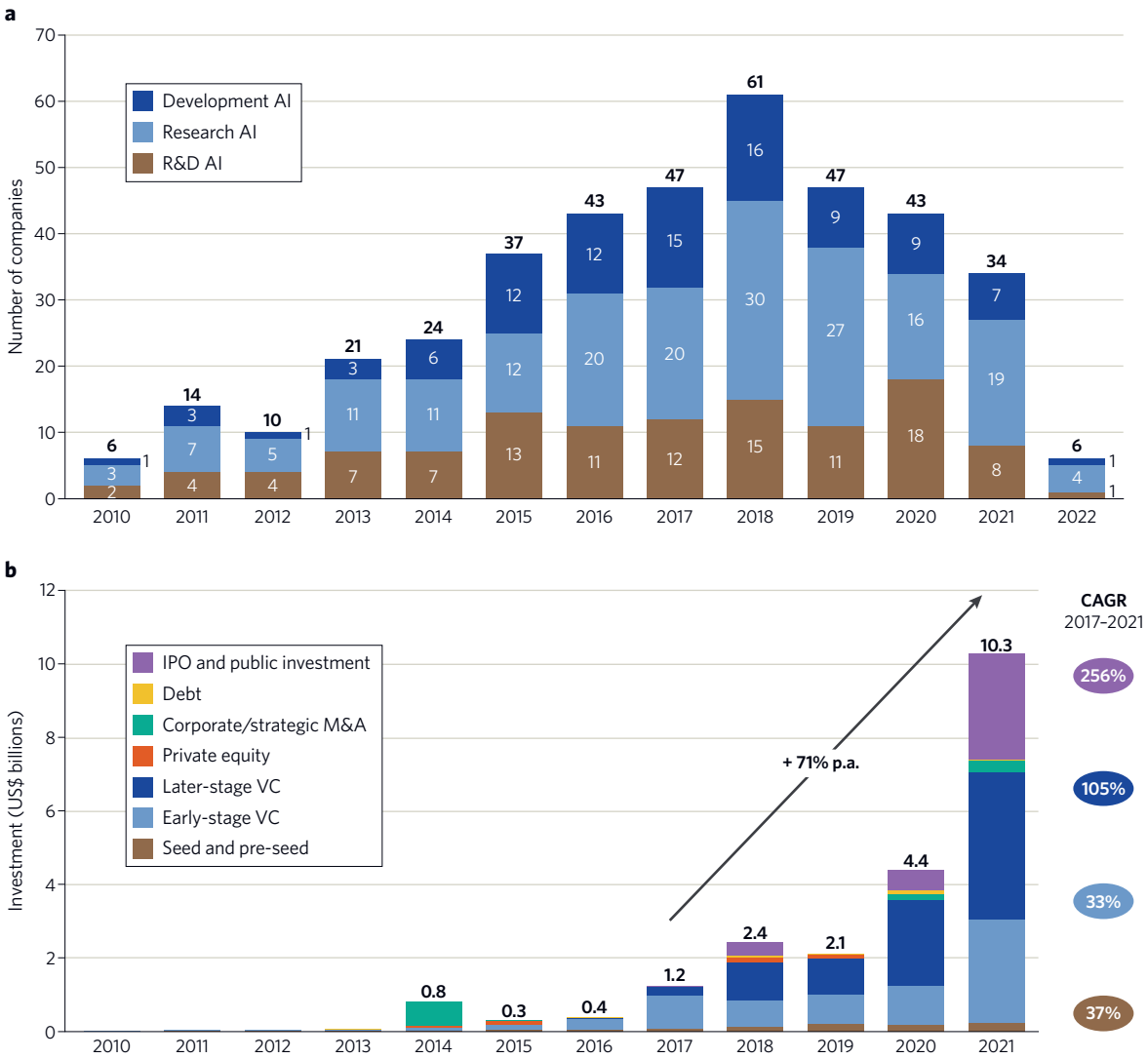

Fig. 1 | Trends in the landscape for AI-driven biotech companies. a, Number of companies founded per year, categorized by focus (research and/or development). Data for 2022 are partial. **b**, Company financing, by investment category, demonstrating a shift from private to public market funding. For details of the data and analysis, see Box 1. AI, artificial intelligence; CAGR, compound annual growth rate; IPO, initial public offering; p.a., per annum; M&A, merger and acquisition; R&D, research and development; VC, venture capital.

The AI-driven company landscape

Our analysis identified ~390 AI-driven biotech companies, of which ~47% focused on aspects of drug discovery research only, ~26% on aspects of drug development, and ~27% on R&D. The number of companies founded each year grew steadily from 2010 to 2018, reaching a peak of ~60, followed by a decline in recent years, probably in part driven by the COVID-19 pandemic and the associated downturn in capital markets (Fig. 1a).

Despite the decline in new company formations, capital deployment into the space grew by a factor of 10 from 2017 to 2021, with a 71% compound annual growth rate (CAGR), and there was an acceleration in later-stage venture capital (VC) financing and initial public offerings (IPOs). For example, five companies had IPOs in 2021, including Recursion, which raised $436 million, and Exscientia, which raised $510 million from a $350 million IPO and a concurrent $160 million private placing. More recently, however, companies in the area have struggled in public markets, with the majority of companies tracked losing value post-IPO (and –15.6% over the first quarter of 2023).

The top 20 companies by total historical fundraising include 'tech natives' with more expansive AI platforms, often combining research data (literature and '-omics') and clinical development data (clinical trials and patient records) to support biopharma companies through partnerships, such as Exscientia and Tempus. There are also companies with AI at their core that identify targets and feed them into their own pipeline, such as Relay Therapeutics and Recursion Pharmaceuticals. Finally, some players sit somewhere in the middle with a partnership proposition based on their technology and an in-house pipeline, such as Insilico Medicine.

There is significant variation in the partnership and business models that companies have adopted, as well as in the scale and structure of the partnership deals (Table 1). The number of these newly announced partnerships has grown significantly in the past 5 years—from 13 in 2017 to over 50 in 2021—with some early successes resulting in the extension and development of collaborations. Conversely, whilst they are less-frequently reported, partnerships have also been terminated at earlier stage gates. A few notable examples of deals in this space, including deal structure and examples of impact delivered, are shown in Table 1.

The road ahead

After a period of hype, we are now starting to see impact in the AI-driven biotech company space, with a few companies having taken candidate molecules into clinical trials or partnered with

Table 1 | Selected partnerships with AI-driven biotech companies with reported impact

Year	AI-driven company	Partner company	Deal focus	Deal summary at time of signing	Publicly reported evidence of impact
2019	ConcertAI (formerly Concerto HealthAI)	Bristol Myers Squibb	Real-world evidence	Bristol Myers Squibb will use Concerto HealthAI's real-world data and AI platform to accelerate clinical trials and generate insights for precision oncology.	In 2022, the first participant was enrolled through ConcertAI's digitally accelerated clinical trial (DACT) model.
2019	BenevolentAI	AstraZeneca	Target identification	AstraZeneca and BenevolentAI will collaborate to use AI in the discovery and development of new drugs for chronic kidney disease and idiopathic pulmonary fibrosis.	Five targets were identified: two for chronic kidney disease and three for idiopathic pulmonary fibrosis. The collaboration was extended for another 3 years in 2022.
2020	Exscientia	Bayer	Small-molecule discovery/design	Exscientia will collaborate with Bayer to accelerate the discovery of small-molecule drugs in cardiovascular disease and oncology using Exscientia's AI-based platform. Exscientia may be eligible to receive up to €240 million in upfront and milestone payments.	Two targets were identified. The collaboration ended in 2022.
2020	Tempus	Janssen	Biomarker development and patient identification	Tempus will work with Janssen researchers focused on oncology clinical development, including developing an AI-based model to enhance enrolment in Janssen's biomarker-driven clinical trials.	The agreement was expanded in 2021 to include other AI-based tools and real-world evidence.
2021	Recursion	Genentech/Roche	Target identification and indication finding	Recursion will work with Roche and Genentech to use Recursion's AI-guided high-content screening platform to identify targets and medicines in neuroscience and oncology. Recursion received an upfront payment of $150 million and is eligible for milestone payments of $300 million each for up to 40 research programs.	In 2022, the partners highlighted progress towards a whole-genome map of human cellular biology for an oncology indication of interest.
2021	Schrödinger	Bristol Myers Squibb	Small-molecule discovery/design	Schrödinger will leverage its physics-based computational platform to discover drug candidates in oncology and immunology for development by Bristol Myers Squibb. Schrödinger received an upfront payment of $55 million and is eligible for milestone payments of up to $2.7 billion.	The agreement was expanded in 2021 to include neurology as a target disease area, with an additional upfront payment.
2021	Exscientia	Bristol Myers Squibb	Small-molecule discovery/design	In an expansion of Exscientia's original deal with Celgene in 2019 (later acquired by Bristol Myers Squibb), the collaboration will seek to leverage Exscientia's AI-driven drug discovery platform to identify novel drug candidates. Exscientia received an upfront payment of $50 million and is eligible for milestone payments of up to $1.2 billion.	Clinical trials for one candidate launched in February 2023. Bristol Myers Squibb declined options for two additional molecules in March 2023.

AI, artificial intelligence.

major companies that have done so. For example, Insilico Medicine, a company developing an end-to-end AI platform, has completed phase 1 for its lead candidate INS018-055 for fibrotic diseases, while Exscientia and Relay Therapeutics have reported the progression of candidates developed in partnership with Sumitomo Dainippon Pharma and Genentech/Roche, respectively. More broadly, we are also observing AI being successfully leveraged by teams in major biopharma companies to accelerate R&D timelines, increase probability of research success, and enhance asset value through identification of relevant subpopulations and novel indications. However, this traction is not yet widespread.

The decline in the number of 'new' AI-driven biotech companies registered (Fig. 1a) is driven by stressed capital markets, increasingly intense competition in the space for partnerships with major biopharma companies, and an ever-increasing technology and data moat established by incumbents. This may lead to a continued decline in the number of new AI-driven biotech companies, or a refocusing of companies towards specific use-cases that are not yet saturated by existing companies, such as RNA-based therapeutics.

We anticipate there will be greater merger and acquisition (M&A) activity in the next few years, as macroeconomic trends continue to squeeze investment in companies in this space; a notable recent example is Recursion's acquisition of Cyclica and Valence. Other companies will go out of business altogether. Of particular relevance to AI-driven biotech companies with a business model that is focused on partnering, we have also observed that major biopharma companies are increasingly developing their own AI-technology backbone and capabilities, as well as having higher expectations and greater discernment within their partnerships with AI-driven companies. However, across both acquisitions and partnerships, challenges have been observed in integrating 'tech-first' companies with existing 'wet-lab' capabilities, and in unlocking synergies through process integration.

In our experience, the companies that achieve AI-enabled acceleration are those with capabilities bridging disparate imperfect datasets and therapeutic modalities, a thoughtfully designed tech stack to allow rapid adoption of AI advances, and successful integration of in silico systems with scientific and operational processes.

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Competing interests
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