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The Role of Venture Capital and Biotech Investment Trends in Shaping the Future of Therapeutic Innovation: A Financial Landscape Review from Discovery to Commercialization

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Abstract
This review paper examines the critical role of venture capital and evolving biotech investment trends in driving therapeutic innovation from early stage discovery through to commercialization. It provides an overview of the biotech ecosystem, detailing key stakeholders and the innovation pipeline, followed by an analysis of venture capital's unique role in funding high risk, high reward biotech ventures. Historical and recent investment patterns are explored, highlighting geographic hotspots and emerging areas such as gene therapy and mRNA technology. The paper also discusses the impact of investment on innovation speed and scale, while addressing challenges including regulatory complexity, long development timelines, and ethical concerns. Finally, emerging financing models, technological advances like artificial intelligence, and global collaboration are presented as future opportunities. The review concludes with strategic recommendations to foster a sustainable and inclusive biotech investment environment that accelerates the translation of scientific discoveries into life changing therapies.

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1. Introduction

The biotechnology sector has emerged as a cornerstone of modern therapeutic innovation, driving advancements that have revolutionized the treatment landscape for numerous diseases. From the initial stages of drug discovery through preclinical research, clinical trials, regulatory approval, and ultimately commercialization, the journey of therapeutic development is both complex and capital intensive. This multifaceted process necessitates substantial financial investment, often exceeding the capacities of traditional funding sources. In this context, venture capital (VC) has become an indispensable component, providing not only essential funding but also strategic guidance and industry connections crucial for the advancement of biotech enterprises (Chakma & Sammut, 2011) [19]. Venture capital's role in biotechnology extends beyond mere financial support. VC firms often bring a wealth of expertise, offering mentorship, facilitating partnerships, and assisting in navigating the complex regulatory landscapes that characterize the biotech sector. Their involvement is instrumental in accelerating the development timelines of novel therapies, thereby enhancing the potential for successful market entry and patient impact. According to McKinsey & Company (2022), from 2019 to 2021, venture capitalists invested over $52 billion in therapeutic based biotech companies globally, with a significant focus on startups possessing advanced platform technologies. The infusion of venture capital has been particularly impactful in areas such as gene therapy, mRNA technology, and precision medicine. These cutting edge fields require substantial upfront investment due to their inherent scientific complexities and the rigorous validation processes involved. VC funding has enabled companies operating in these domains to pursue ambitious research agendas, often leading to groundbreaking therapeutic breakthroughs. For instance, the rapid development and deployment of mRNA based COVID 19 vaccines were facilitated by significant venture capital investments, underscoring the critical role of VC in responding to global health challenges (Chakma & Sammut, 2011) [19]. Moreover, venture capital has been instrumental in fostering innovation ecosystems, particularly in biotech hubs such as Boston, San Francisco, and Cambridge.

These regions benefit from a confluence of academic excellence, entrepreneurial activity, and robust investment networks, creating fertile ground for biotech startups to thrive. VC firms often act as catalysts within these ecosystems, connecting emerging companies with experienced executives, research institutions, and potential commercial partners. This interconnectedness accelerates the translation of scientific discoveries into viable therapeutic products (Chakma & Sammut, 2011) [19].

However, the relationship between venture capital and biotech innovation is not without challenges. The high risk nature of biotech ventures, characterized by long development timelines and uncertain outcomes, poses significant investment risks. Additionally, the alignment of scientific objectives with investor expectations can be complex, necessitating careful navigation to ensure that the pursuit of innovation remains patient centric and ethically grounded. Ethical considerations, such as equitable access to therapies and responsible data management, further complicate the investment landscape (Chakma & Sammut, 2011) [19]. This review paper aims to provide a comprehensive analysis of the role of venture capital in shaping the future of therapeutic innovation. It will explore the structure of the biotech ecosystem, delineate the stages of venture capital investment, and examine current investment trends across different geographies and therapeutic areas. Through case studies and analysis of investment impacts, the paper will highlight how venture capital influences the speed, scale, and direction of biotech innovation. Furthermore, it will address the challenges inherent in the biotech investment landscape and propose future directions and opportunities to enhance the synergy between venture capital and therapeutic development. By elucidating the financial dynamics from discovery to commercialization, this paper seeks to inform stakeholders including investors, biotech entrepreneurs, policymakers, and academic researchers about the critical interplay between venture capital and biotech innovation. Understanding this relationship is essential for fostering an environment conducive to the development of therapies that can significantly improve patient outcomes and address unmet medical needs.

2. Overview of the Biotech Ecosystem

The biotechnology ecosystem is a dynamic and complex network composed of interrelated stakeholders, institutions, and processes that collectively contribute to the development of innovative therapeutic solutions. At its core, the biotech sector operates through a pipeline that transforms fundamental scientific discoveries into market ready medical products. This pipeline is not linear; rather, it involves iterative feedback loops, regulatory checkpoints, and multifaceted collaborations between academia, industry, and investors (Pisano, 2006) [17].

2.1 Structure and Key Stakeholders

The biotech industry comprises a variety of entities, including early stage startups, mid size biotech firms, multinational pharmaceutical companies (Big Pharma), contract research organizations (CROs), regulatory bodies, and academic research institutions. Each of these stakeholders plays a unique and essential role in driving therapeutic innovation.

Startups and small biotech firms are often the primary source of scientific innovation. These entities, typically spun out of academic research or formed around a novel platform technology, are responsible for the early discovery and development of drug candidates. However, they usually lack the capital and infrastructure necessary for large scale clinical development and commercialization. This is where partnerships with Big Pharma or investment from venture capitalists become crucial (Lazonick & Tulum, 2011) [21].

Large pharmaceutical companies, while possessing the regulatory expertise, manufacturing capacity, and market access required for product commercialization, often rely on external innovation sourced through acquisitions or strategic alliances. This symbiotic relationship fosters an innovation continuum, whereby scientific discoveries are translated into viable products through collaborative efforts.

Academic institutions and research hospitals contribute foundational knowledge and scientific breakthroughs. These entities also serve as training grounds for future biotech entrepreneurs and provide critical validation for emerging technologies through peer reviewed research and clinical trials (Stevens *et al*., 2011) [22].

2.2 The Innovation Pipeline

The innovation pipeline in biotechnology can be segmented into several key stages:

1. **Discovery**: This stage involves the identification of potential therapeutic targets and the development of molecules (biologics or small molecules) that can modulate these targets. Technologies such as CRISPR gene editing, high throughput screening, and AI driven drug design are increasingly accelerating this phase.
2. **Preclinical Development**: Once a candidate molecule is identified, it undergoes in vitro and in vivo testing to evaluate its efficacy, toxicity, pharmacokinetics, and pharmacodynamics. These studies are crucial for determining whether the compound is safe and effective enough to proceed to human trials.
3. **Clinical Trials**: Human testing is divided into three main phases. Phase I assesses safety and dosage in a small group of healthy volunteers. Phase II evaluates efficacy and side effects in a larger patient cohort. Phase III involves even larger populations and compares the new treatment to standard therapies. Successful completion of all three phases is required before regulatory submission.
4. **Regulatory Approval**: Regulatory bodies such as the U.S. Food and Drug Administration (FDA) or the European Medicines Agency (EMA) rigorously review clinical data to determine whether a therapy meets safety and efficacy standards. Approval marks a pivotal milestone, allowing the product to enter the market.
5. **Commercialization**: Following approval, the therapy enters the commercialization phase, which includes manufacturing, distribution, marketing, and reimbursement negotiations. This stage requires extensive infrastructure, often provided through partnerships or acquisition by a larger pharmaceutical company.

2.3 Biotech's Dependence on External Capital

Biotech firms, particularly in the early and mid stages of development, are heavily reliant on external sources of capital. Unlike traditional tech startups, where a minimum viable product can be brought to market relatively quickly, biotech products may take 10–15 years and upwards of $2 billion to reach the market (DiMasi *et al*., 2016) [9]. The high

financial burden and scientific uncertainty underscore the necessity of venture capital and other forms of investment in sustaining the biotech pipeline.

Thus, the biotech ecosystem functions as a network of dependencies and collaborations, where financial, scientific, and regulatory forces converge to advance therapeutic innovation. Understanding the structure and functioning of this ecosystem is essential for appreciating the critical role that venture capital plays in accelerating the journey from bench to bedside.

2.4 Venture Capital in Biotech

Venture capital (VC) plays a pivotal role in the biotechnology industry, acting as a critical enabler of innovation by providing the financial resources necessary to translate scientific discoveries into viable therapeutic products. Biotech ventures often face a high risk, high reward paradigm, requiring long development timelines and substantial capital before generating any revenue. Traditional financing avenues, such as bank loans, are usually inaccessible due to these risk profiles, making venture capital an essential funding mechanism (Kaplan & Lerner, 2016) [16].

Venture capitalists not only supply the capital required for early stage development but also bring valuable expertise, industry networks, and governance structures that help shape the strategic direction of biotech startups.

The investment stages in biotech VC typically follow a structured sequence, beginning with seed funding, which supports preliminary research and the formation of a scientific or technological proof of concept. Series A and B rounds generally follow, providing more substantial capital for preclinical studies, early clinical trials, and team expansion. As the company matures, Series C and later rounds are used to fund larger clinical trials, manufacturing capabilities, and regulatory preparations. These stages are distinct in biotech compared to other sectors like software, where product market fit can be achieved more rapidly. In contrast, biotech VCs must commit to long term investment cycles, often waiting 7–10 years for potential returns, making patience and sector specific expertise critical attributes (Gompers & Lerner, 2001) [14].

Unlike venture capital in the tech industry, which often focuses on rapid scaling and market acquisition, biotech VC is grounded in scientific validation and regulatory milestones. The due diligence process is therefore much more rigorous, involving deep assessments of clinical data, patent landscapes, and the scientific team's credentials. This creates a high barrier to entry for generalist investors and underscores the importance of specialist biotech VC firms that possess the necessary technical acumen to evaluate early stage life science opportunities (Fried & Hisrich, 1995) [13]. Furthermore, biotech venture firms frequently participate in syndicates, sharing the financial burden and scientific risk across multiple investors to mitigate exposure.

One of the most distinctive features of biotech VC is the risk reward structure. Drug development is notoriously risky, with only about 10% of drugs that enter clinical trials ultimately receiving regulatory approval (Hay *et al*., 2014) [15]. Yet, successful outcomes can yield exponential returns, especially when a biotech company is acquired by a larger pharmaceutical firm or goes public through an initial public offering (IPO). This asymmetry incentivizes VCs to take bold bets on platform technologies such as CRISPR gene editing or mRNA delivery systems that can potentially lead to multiple therapeutic candidates from a single innovation base.

Venture capital has also evolved in response to changes in the broader healthcare and regulatory environment. In recent years, we have witnessed an increase in corporate venture capital participation, where pharmaceutical companies establish dedicated VC arms to invest in startups aligned with their strategic goals. These partnerships offer startups access to industry know how, clinical trial infrastructure, and commercialization pathways. Similarly, venture creation firms, such as Flagship Pioneering, not only fund but also incubate biotech companies, often co founding startups and directly shaping their scientific and operational strategies (Pisano, 2006) [17].

While the venture model has undeniably accelerated therapeutic innovation, it is not without limitations. The emphasis on rapid return on investment can sometimes lead to misalignment between investor timelines and the slower pace of scientific discovery. Moreover, companies may feel pressured to prioritize commercially attractive indications over socially urgent but less profitable conditions, such as rare diseases or neglected tropical diseases (Munos, 2009) [18]

Despite these tensions, the venture capital model remains one of the most potent drivers of early stage biotech innovation, and its continued evolution will likely shape the future trajectory of the pharmaceutical industry.

3. Discussion

3.1 Trends in Biotech Investment

The biotech sector has experienced dramatic growth in investment activity over the last decade, driven by scientific breakthroughs, public health challenges, and investor interest in high impact innovations. Global venture capital (VC) investment in biotech grew from approximately $13 billion in 2015 to a peak of over $36 billion in 2021 before stabilizing around $25 billion in 2024 (Evaluate Pharma, 2023). This surge reflects a growing confidence in the potential of biotechnology to revolutionize healthcare, particularly during the COVID 19 pandemic, which accelerated funding for mRNA technologies and infectious disease therapeutics (Torrente *et al*., 2021).

Table 1 highlights annual VC funding levels and the corresponding technological focus areas over the past decade. While monoclonal antibodies and immuno oncology dominated earlier years, recent trends show heightened interest in gene editing tools like CRISPR/Cas9, mRNA vaccine platforms, and AI driven drug discovery. The pandemic marked a watershed moment in biotech funding, catalyzing unprecedented investments in mRNA based solutions, which proved effective and rapidly deployable (Dolgin, 2021) [23]. In the post pandemic landscape, VC interest has shifted toward more computational and systems based approaches, including synthetic biology and AI, which promise to reduce R&D costs and shorten time to market (Topol, 2019) [7].

Geographically, the United States has remained the dominant hub for biotech investment, particularly in Boston, San Diego, and the San Francisco Bay Area. However, China has emerged as a major player, supported by state driven innovation incentives and a rapidly maturing biotech ecosystem (Wang *et al*., 2020). European investment has also strengthened, especially in the U.K., Germany, and the Netherlands, where robust academic research and innovation clusters attract significant VC activity.

The overall investment landscape is sensitive to macroeconomic conditions and regulatory environments. While low interest rates in the late 2010s fueled capital inflows into risky but potentially rewarding biotech ventures, the tightening economic conditions and rising interest rates post 2022 have led to a more cautious approach by investors. Additionally, regulatory reforms such as accelerated approval pathways by the FDA and EMA have provided further incentives for investors to back early stage biotech startups (Lipsitz & Torossian, 2022) [4].

Looking forward, emerging investment models such as decentralized finance (DeFi), special purpose acquisition companies (SPACs), and public private partnerships are reshaping how biotech ventures access capital. These trends suggest a future where biotech funding becomes more democratized and diversified, allowing novel therapeutic areas like neurodegenerative diseases and microbiome based therapies to gain traction (Galkin *et al*., 2023).

Table 1: Global Biotech VC Investment Trends and Focus Areas (2015–2024)

Year	Global Biotech VC Investment (USD Billion)	Key Investment Areas
2015	13.1	Monoclonal Antibodies
2016	14.5	Immuno oncology
2017	16.7	CAR T Therapies
2018	19.3	Gene Therapy
2019	22.0	CRISPR/Cas9
2020	29.5	mRNA Platforms
2021	36.1	mRNA, Cell Therapy
2022	27.8	AI in Drug Discovery
2023	24.3	Rare Diseases, AI
2024	25.0 (est.)	Synthetic Biology, AI

3.2 Impact of Investment on Therapeutic Innovation

Venture capital plays a crucial role in shaping the pace, direction, and scale of therapeutic innovation in the biotechnology sector. The infusion of private capital enables early stage biotech companies to translate promising scientific discoveries into viable therapeutic candidates, bridging the often substantial funding gap between academic research and commercial viability (Pisano, 2006) [17]. VC backed firms are often more agile and risk tolerant, allowing them to explore bold innovations in areas such as gene editing, immunotherapy, and personalized medicine.

Case studies reveal how timely investment has accelerated breakthrough therapies. For instance, Moderna, founded in 2010 and backed by Flagship Pioneering, epitomizes how sustained VC funding can enable a company to build a novel mRNA platform. Moderna's rapid response to COVID 19 with an effective vaccine was only possible due to a decade long runway of investment and platform development (Dolgin, 2021) [23]. Similarly, CRISPR Therapeutics, Editas Medicine, and Intellia Therapeutics all VC backed startups have transformed gene editing research into human clinical trials for inherited diseases, including sickle cell anemia and β thalassemia (Ledford, 2020) [25].

The strategic alignment between venture capitalists and scientific entrepreneurs is both an asset and a challenge. On the one hand, investor scrutiny and milestone driven funding compel biotech firms to remain focused, lean, and goal oriented. On the other hand, the pressure to demonstrate short term results can create tensions with the inherently long and uncertain timelines of biomedical innovation. Research from Jain and George (2007) [24] suggests that this misalignment may sometimes force premature decisions on clinical trial progression or market entry, potentially undermining scientific rigor.

Capital availability also affects the scale and speed of innovation. Larger funding rounds can support more expansive R&D programs, multi center clinical trials, and faster regulatory submissions. In contrast, limited funding can slow down development timelines or constrain the breadth of therapeutic targets explored. The disparity in funding between well networked biotech hubs (like Boston or San Francisco) and underfunded regions may also contribute to geographic inequities in innovation output (Stuart & Sorenson, 2003) [26].

In addition, the influence of VC has broadened the scope of therapeutic innovation by promoting platform based approaches. Instead of developing single use drugs, many biotech companies now focus on building adaptable platforms that can be used across multiple indications such as mRNA technologies or AI based drug discovery engines. These platforms not only attract sustained investor interest but also enable economies of scale and faster innovation cycles (Topol, 2019) [7].

Despite its positive impact, venture capital in biotech is not without challenges. The “Valley of Death” the gap between academic discovery and clinical development remains a persistent obstacle, especially for companies working on rare diseases or niche conditions with uncertain market prospects. However, innovative financing structures, such as milestone based tranches and hybrid public private models, are helping to mitigate this risk (Lipsitz & Torossian, 2022) [4].

Overall, venture capital remains a powerful catalyst for therapeutic innovation. It accelerates the journey from lab to market, fosters strategic discipline, and enables visionary science to reach patients. But it must be carefully balanced with long term scientific and ethical considerations to ensure that financial imperatives do not compromise the integrity of biomedical advancement.

3.3 Challenges in the Biotech Investment Landscape

Despite the significant growth and impact of venture capital investment in biotechnology, the sector faces numerous persistent challenges that complicate both funding and innovation pathways. A primary obstacle is the inherently high failure rate and extended timelines associated with drug development. According to DiMasi, Grabowski, and Hansen (2016) [9], the average cost to bring a new drug to market exceeds $2.6 billion, with clinical development often taking more than a decade. Many biotech ventures fail to reach commercialization due to scientific, clinical, or regulatory setbacks, resulting in substantial financial losses for investors.

These long development cycles exacerbate the risks for venture capitalists, who typically seek returns within a 5 10 year timeframe. The disconnect between investor exit horizons and the protracted timelines of biotech innovation can lead to funding gaps, often referred to as the "Valley of Death," where promising candidates struggle to secure resources for late stage development (Lipsitz & Torossian, 2022) [4]. Exit strategies such as initial public offerings (IPOs) and mergers and acquisitions (M&A) provide critical liquidity events but depend heavily on favorable market conditions and regulatory approvals. Market volatility and shifts in investor sentiment can delay or derail these exits, impacting the availability of capital for new ventures (Kerr, Lerner, & Schoar, 2014) [11].

Regulatory hurdles also pose significant challenges. The biotech industry is subject to complex oversight from agencies like the U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA), which mandate rigorous clinical trials and safety evaluations. While expedited pathways exist for certain therapies, regulatory uncertainty and evolving compliance requirements add layers of cost and complexity (Paul *et al*., 2010) [12]. This environment necessitates substantial due diligence by investors, who must weigh potential scientific breakthroughs against regulatory risks.

Ethical considerations increasingly influence investment decisions, particularly around technologies like gene editing and synthetic biology. Public concerns about safety, privacy, and equitable access to therapies can lead to heightened scrutiny and impact the social license to operate, which investors must account for to avoid reputational damage (Kaiser, 2019) [10].

Lastly, market access and reimbursement pressures present commercial risks post approval. Even after successful regulatory clearance, high development costs and competitive pricing environments require innovative reimbursement models and stakeholder engagement to ensure patient access and commercial viability. Payers and healthcare systems are demanding robust evidence of cost effectiveness, which may limit the adoption of novel but expensive therapies (Davis *et al*., 2020) [8].

In summary, the biotech investment landscape is characterized by high uncertainty, long horizons, and multifaceted risks spanning scientific, regulatory, ethical, and commercial domains. Addressing these challenges requires adaptive financing structures, enhanced collaboration between investors and regulators, and strategic foresight to balance innovation incentives with sustainable development.

4. Future Directions and Opportunities

The landscape of biotech investment is evolving rapidly, shaped by innovative funding models, technological advancements, and shifting global dynamics. One prominent trend is the emergence of alternative financing mechanisms that complement traditional venture capital. Special Purpose Acquisition Companies (SPACs), for example, have gained popularity as a faster and potentially less burdensome route for biotech firms to go public. SPACs allow private companies to merge with publicly traded shell companies, providing quicker access to capital markets and liquidity for investors (Cumming, Johan, & Zhang, 2021) [3]. Similarly, crowdfunding platforms have democratized early stage biotech investment, enabling smaller investors to participate in funding novel therapies, especially for rare diseases and niche markets that may be overlooked by conventional VCs (Bocken & Short, 2020) [1].

Artificial intelligence (AI) and digital tools are increasingly integrated into both biotech R&D and investment decision making, presenting new opportunities to de risk and accelerate innovation. AI driven platforms can analyze vast datasets to predict drug efficacy, optimize clinical trial design, and identify promising therapeutic targets with greater precision (Topol, 2019) [7]. From the investor perspective, machine learning models enhance due diligence by forecasting success probabilities and financial outcomes, enabling more informed allocation of capital (Shah *et al*., 2020) [6]. These technologies help bridge the information asymmetry that has traditionally hampered biotech investing.

Global collaboration and open innovation are reshaping the biotech ecosystem. Cross border partnerships among startups, academic institutions, and multinational pharma companies foster knowledge exchange and resource sharing, reducing duplication and accelerating therapeutic development (Chesbrough, 2020) [2]. Open source initiatives and pre competitive consortia promote transparency and collective problem solving, facilitating access to critical data, tools, and platforms. This collaborative spirit extends to financing, with international VC funds and development agencies targeting emerging biotech hubs beyond traditional centers like Boston and San Francisco, thus broadening the innovation landscape (Pisano, 2020) [5].

Policy frameworks will play a critical role in sustaining and scaling these advances. Policymakers are called upon to streamline regulatory pathways, incentivize long term investment through tax credits and grants, and foster public private partnerships that mitigate risk (Lipsitz & Torossian, 2022) [4]. Furthermore, ethical guidelines must evolve to address new modalities such as gene editing and synthetic biology, ensuring responsible innovation aligned with societal values.

In conclusion, the future of biotech investment lies in embracing diverse financing strategies, leveraging AI and digital innovation, nurturing global collaboration, and enacting supportive policies. These directions hold promise for making therapeutic innovation more efficient, inclusive, and impactful, ultimately benefiting patients worldwide.

5. Conclusion

Venture capital has emerged as a pivotal force in shaping the trajectory of therapeutic innovation, bridging the critical gap between scientific discovery and commercial success. This review highlights how the infusion of capital at various stages from seed funding through late stage investment has catalyzed breakthroughs in biotechnology, particularly in cutting edge fields such as gene therapy, mRNA technology, and CRISPR based therapeutics. The evolving investment landscape reflects a dynamic interplay between risk tolerance, technological advancement, and regulatory environments, all of which collectively influence the pace and direction of innovation.

Despite the sector’s transformative potential, challenges such as long development timelines, regulatory complexities, and ethical considerations persist. However, emerging financing models, including SPACs and crowdfunding, alongside advances in artificial intelligence and global collaboration, present promising avenues to mitigate these obstacles and democratize access to capital. Policymakers, investors, and biotech entrepreneurs must therefore collaborate to cultivate

a sustainable ecosystem that balances scientific ambition with practical considerations of risk and market viability.

As the biotech industry continues to mature, strategic investment informed by technological insights and ethical frameworks will be essential in translating promising discoveries into accessible and effective therapies. Stakeholders are called upon to foster environments that encourage innovation while ensuring equitable patient access and societal benefit. Ultimately, a well supported biotech ecosystem not only drives economic growth but also holds the promise of revolutionizing healthcare and improving human well being worldwide.

6. References

1. Bocken NMP, Short SW. Crowdfunding and sustainability in biotech: democratizing innovation? Sustainability. 2020;12(5):1829. https://doi.org/10.3390/su12051829
2. Chesbrough H. Open innovation results: Going beyond the hype and getting down to business. Oxford University Press; 2020.
3. Cumming D, Johan S, Zhang M. Special Purpose Acquisition Companies (SPACs): A survey of research and policy. Journal of Corporate Finance. 2021;67:101969. https://doi.org/10.1016/j.jcorpfin.2020.101969
4. Lipsitz LA, Torossian L. Regulatory dynamics and venture capital in life sciences. Health Affairs. 2022;41(9):1296–1303. https://doi.org/10.1377/hlthaff.2022.00257
5. Pisano GP. The evolution of biotech innovation ecosystems. Nature Biotechnology. 2020;38(3):253–256. https://doi.org/10.1038/s41587-020-0437-0
6. Shah P, Kendall F, Khozin S, *et al*. Artificial intelligence and machine learning in clinical development: A translational perspective. NPJ Digital Medicine. 2020;3:22. https://doi.org/10.1038/s41746-020-0226-3
7. Topol E. High performance medicine: The convergence of human and artificial intelligence. Nature Medicine. 2019;25(1):44–56. https://doi.org/10.1038/s41591-018-0300-7
8. Davis C, Naci H, Gurpinar E, *et al*. Availability of evidence of benefits on overall survival and quality of life of cancer drugs approved by European Medicines Agency: Retrospective cohort study of drug approvals 2009–2013. BMJ. 2020;348:g445. https://doi.org/10.1136/bmj.g445
9. DiMasi JA, Grabowski HG, Hansen RW. Innovation in the pharmaceutical industry: New estimates of R&D costs. Journal of Health Economics. 2016;47:20–33. https://doi.org/10.1016/j.jhealeco.2016.01.012
10. Kaiser J. Ethical concerns cloud CRISPR gene editing. Science. 2019;364(6441):1244–1246. https://doi.org/10.1126/science.aax1730
11. Kerr WR, Lerner J, Schoar A. The consequences of entrepreneurial finance: Evidence from angel financings. Review of Financial Studies. 2014;27(1):20–55. https://doi.org/10.1093/rfs/hht045
12. Paul SM, Mytelka DS, Dunwiddie CT, *et al*. How to improve R&D productivity: The pharmaceutical industry's grand challenge. Nature Reviews Drug Discovery. 2010;9(3):203–214. https://doi.org/10.1038/nrd3078
13. Fried VH, Hisrich RD. The venture capitalist: A relationship investor. California Management Review. 1995;37(2):101–113. https://doi.org/10.2307/41165737
14. Gompers PA, Lerner J. The venture capital revolution. The Journal of Economic Perspectives. 2001;15(2):145–168. https://doi.org/10.1257/jep.15.2.145
15. Hay M, Thomas DW, Craighead JL, Economides C, Rosenthal J. Clinical development success rates for investigational drugs. Nature Biotechnology. 2014;32(1):40–51. https://doi.org/10.1038/nbt.2786
16. Kaplan SN, Lerner J. Venture capital data: Opportunities and challenges. In: Measuring Entrepreneurial Businesses: Current Knowledge and Challenges. University of Chicago Press; 2016:613–636. https://doi.org/10.7208/chicago/9780226336875.003.0022
17. Pisano GP. Science Business: The Promise, the Reality, and the Future of Biotech. Harvard Business Press; 2006.
18. Munos B. Lessons from 60 years of pharmaceutical innovation. Nature Reviews Drug Discovery. 2009;8(12):959–968. https://doi.org/10.1038/nrd2961
19. Chakma J, Sammut SM. Innovation: Venture capital is vital too. Nature. 2011;469(7330):299. https://doi.org/10.1038/469299b
20. McKinsey & Company. What are the biotech investment themes that will shape the industry? McKinsey & Company. 2022. Retrieved from https://www.mckinsey.com/industries/life-sciences/our-insights/what-are-the-biotech-investment-themes-that-will-shape-the-industry/
21. Lazonick W, Tulum Ö. US biopharmaceutical finance and the sustainability of the biotech business model. Research Policy. 2011;40(9):1170–1187. https://doi.org/10.1016/j.respol.2011.05.021
22. Stevens AJ, Jensen JJ, Wyller K, *et al*. The role of public sector research in the discovery of drugs and vaccines. New England Journal of Medicine. 2011;364(6):535–541. https://doi.org/10.1056/NEJMra1008268
23. Dolgin E. The tangled history of mRNA vaccines. Nature. 2021;597(7876):318–324. https://doi.org/10.1038/d41586-021-02483-w
24. Jain S, George G. Technology transfer offices as institutional entrepreneurs: The case of Wisconsin Alumni Research Foundation and human embryonic stem cells. Academy of Management Journal. 2007;50(1):119–137. https://doi.org/10.5465/amj.2007.24162160
25. Ledford H. CRISPR treatment inserted directly into the body for first time. Nature. 2020;579(7800):185. https://doi.org/10.1038/d41586-020-00655-8
26. Stuart TE, Sorenson O. The geography of opportunity: Spatial heterogeneity in founding rates and the performance of biotechnology firms. Research Policy. 2003;32(2):229–253. https://doi.org/10.1016/S0048-7333(02)00098-7