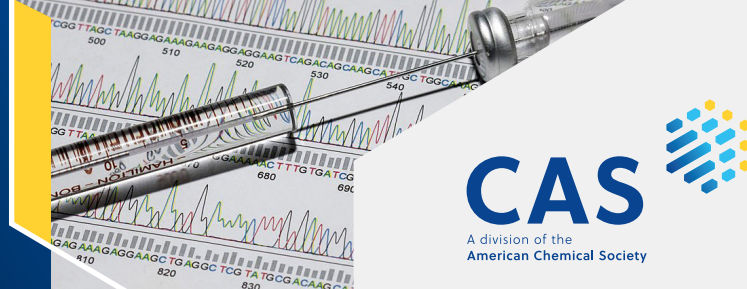


R&D TRENDS: THE POWER OF mRNA IN MODERN MEDICINE



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Overview

The rapid success of the mRNA COVID-19 vaccines has catapulted mRNA to the forefront of drug research. The promise of mRNA-based therapeutics and vaccines in other disease areas is now emerging.

Background: Since its discovery in the 1960s, mRNA has been the subject of systematic basic and applied research aimed at various diseases.

Market data: The mRNA therapeutics market was estimated at \$42.56 billion in 2021 and is expected to reach \$128.14 billion by 2030.

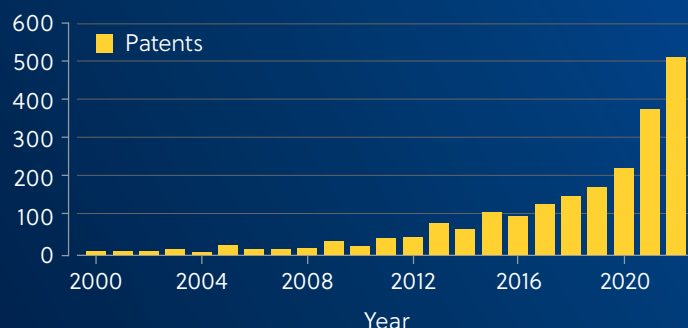
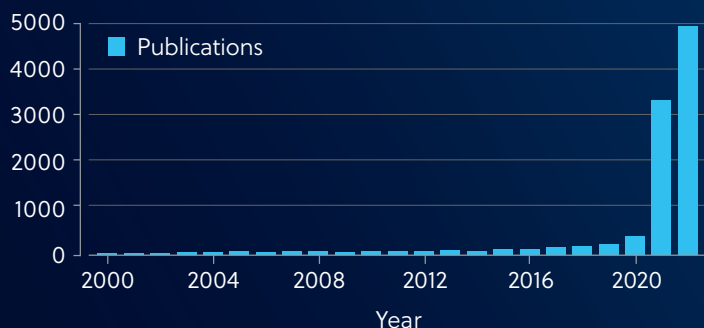
Opportunities: The area of mRNA therapeutics is a key research interest in the global mRNA field, followed by delivery systems and vaccines.

Key benefits: The applications of mRNA technologies are vast, with the potential to revolutionize the treatment of human diseases.

Key challenges: Research efforts are focused on optimizing mRNA formulations to enhance bioavailability, half-life, and carrier efficiency to the targeted tissue.

Trends in mRNA therapeutics and vaccines

Due to the impact of the novel coronavirus outbreak at the end of 2019, mRNA technology has attracted wide attention from researchers, with explosive growth in journal publications and patent applications.

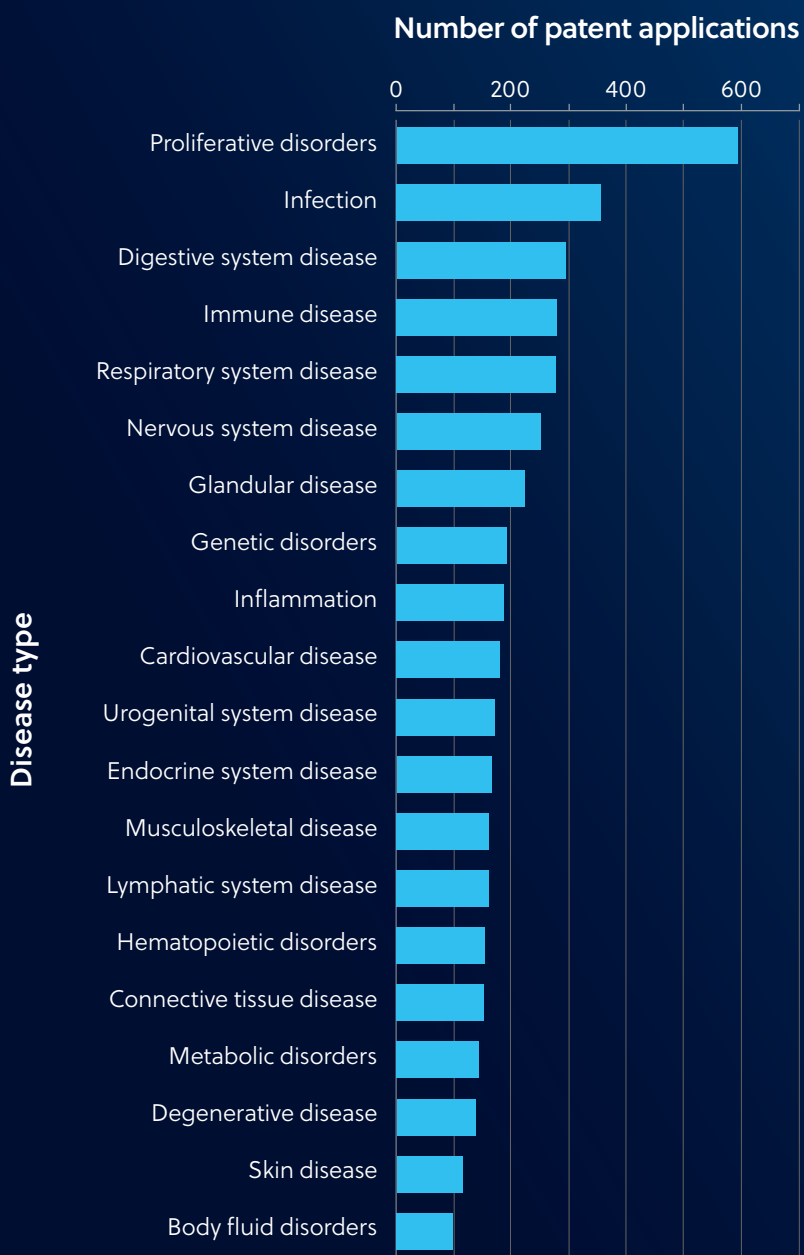


Top 10 organizations with patent applications in mRNA therapeutics or vaccines

U.S.-based companies are leading the way with mRNA patent output, with Moderna holding nearly 30% of patents.

Ranking	Organizations	# of patent applications	Country	Organization type	# of patent applications in recent three years
1	Moderna	207	United States	Company	61
2	CureVac	150	Germany	Company	15
3	BioNTech	135	Germany	Company	59
4	Translate Bio	78	United States	Company	48
5	Tron	53	Germany	Company	11
6	Alnylam Pharmaceuticals	30	United States	Company	2
7	Shire Human Genetic Therapies	28	United States	Company	0
8	University of Pennsylvania	27	United States	University	13
9	Arcturus Therapeutics	23	United States	Company	8
10	Acuitas Therapeutics	21	Canada	Company	5

Key technologies in the global mRNA field



mRNA therapeutics

The number of global patent applications in mRNA therapeutics is on an upward trend. Patent topics related to mRNA therapeutics largely focus on drug research, disease mechanism, immune research, and signaling molecules research. Antitumor agents are a major focus of mRNA therapeutic research.

mRNA modification

Modifying mRNA structural elements can help enhance stability and improve translational efficiency. Trends in mRNA modification have remained stable in recent years, with key patent research topics including drug delivery types, carrier materials, and nucleic acid modification.

mRNA delivery systems

Successful delivery of mRNA to target tissues requires safe, effective, and stable delivery systems that protect the nucleic acid from degradation. Patent research topics in this area focus on methods of delivery (including injection methods), pharmaceutical carriers, and drug packaging.

mRNA vaccines

Unsurprisingly, coronavirus vaccine research is a dominant subject of patent research. However, a large proportion of patents are also focused on tumor vaccine research, particularly in lung, breast, and prostate cancer.

Proliferative disorders lead in patent applications

Proliferative disorders, including neoplasms, have attracted much attention among researchers, with patent applications for neoplasms dominating the field. In particular, a large proportion of patents are in urogenital system neoplasms, indicating that this is a hot topic.

The coronavirus pandemic has been a catalyst for an explosion of research interest in mRNA therapeutics and vaccines. Though challenges remain, the knowledge gained from COVID-19 mRNA vaccine research is set to transform the management of many of difficult-to-treat conditions, including cancer.

Learn more at cas.org/insights

More comprehensive information and references can be found at: cas.org/mrna

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