

# **Gene Synthesis Market - Global Industry Size, Share, Trends, Opportunity, and Forecast, 2018-2028 Segmented By Method (Solid-phase Synthesis, Chip-based Synthesis, PCR-based Enzyme Synthesis), By Service (Antibody DNA Synthesis, Viral DNA Synthesis, Others), By Application (Gene & Cell Therapy Development, Vaccine Development, Disease Diagnosis, Others), By End Use (Biotechnology and Pharmaceutical Companies, Academic and Government Research Institutes, Contract Research Organizations) By Region and Competition**

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## **Abstracts**

Global Gene Synthesis Market has valued at USD 1.82 billion in 2022 and is anticipated to grow with a CAGR of 9.24% through 2028. The Gene Synthesis market is a burgeoning sector within the biotechnology industry, characterized by the custom production of artificial DNA sequences. It plays a pivotal role in various fields such as genetic engineering, pharmaceuticals, and synthetic biology. The market's growth is primarily driven by advancements in DNA synthesis technologies, reduced costs, and increasing demand for tailored genetic constructs for research and therapeutic purposes. With applications ranging from vaccine development to gene therapy, the Gene Synthesis market is poised for continued expansion as it empowers scientists and researchers to design and construct genes with precision, fostering innovation across multiple domains.

### Key Market Drivers

## Rising investment in synthetic biology market

The rising investment in the synthetic biology market has emerged as a significant driver for the Gene Synthesis market. Synthetic biology, a multidisciplinary field that combines biology with engineering principles, is experiencing a surge in funding and interest from various sectors, including biotechnology, pharmaceuticals, energy, and agriculture. This investment is fundamentally reshaping the landscape of genetic research and applications, with gene synthesis playing a pivotal role. One key aspect of synthetic biology is the design and construction of novel biological parts, devices, and systems. Gene synthesis is the enabling technology that allows scientists and engineers to create custom DNA sequences with precision. As investment in synthetic biology grows, there is a heightened demand for synthesized genes to build and optimize synthetic biological systems. Researchers are increasingly relying on gene synthesis services to design and produce the genetic components required for their projects, from engineered microbes for biomanufacturing to gene circuits for medical applications.

Moreover, the expansion of synthetic biology into diverse industries such as biomanufacturing, biofuels, agriculture, and healthcare is propelling the Gene Synthesis market forward. Investment in these sectors is driving innovation and driving the need for synthetic genes tailored to specific applications. This symbiotic relationship between synthetic biology and gene synthesis is creating a feedback loop, with each field reinforcing the other's growth. Furthermore, the infusion of capital into synthetic biology startups and research initiatives is fostering technological advancements in gene synthesis. Companies are investing in research and development to improve the efficiency, cost-effectiveness, and automation of gene synthesis processes. These innovations are making gene synthesis more accessible and affordable, attracting a broader range of researchers and industries. In conclusion, the rising investment in the synthetic biology market serves as a powerful catalyst for the Gene Synthesis market. It fuels demand for custom DNA sequences, accelerates innovation in genetic engineering, and supports the development of novel applications across various sectors. As synthetic biology continues to flourish, the Gene Synthesis market is likely to see sustained growth and transformation, unlocking new possibilities in biotechnology and beyond.

## Advent of enzymatic DNA synthesis process

The advent of enzymatic DNA synthesis processes has emerged as a significant driver for the Gene Synthesis market, transforming the landscape of genetic research and

biotechnology applications. Enzymatic DNA synthesis represents a revolutionary leap forward in the field of gene synthesis, offering several key advantages that are reshaping the industry. Firstly, enzymatic DNA synthesis methods, such as DNA polymerase-based techniques, provide higher fidelity and accuracy compared to traditional chemical synthesis approaches. This results in fewer errors and mutations in synthesized genes, making them more reliable for scientific research, drug development, and therapeutic applications. Researchers and biotech companies increasingly turn to enzymatic synthesis for their need for precise and error-free DNA constructs. Secondly, enzymatic DNA synthesis is more sustainable and environmentally friendly. It reduces the use of hazardous chemicals and solvents typically associated with chemical DNA synthesis, aligning with the growing emphasis on eco-friendly practices in the biotechnology sector. This sustainability aspect not only appeals to environmentally conscious organizations but also reflects positively on the reputation of gene synthesis providers.

Furthermore, enzymatic DNA synthesis processes offer greater flexibility and scalability. Researchers can easily modify and optimize DNA sequences, enabling rapid iterations for experimental design and adaptation to changing research needs. The scalability of enzymatic synthesis allows for the efficient production of both small-scale research constructs and large-scale industrial applications, such as biofuel production or gene therapy vectors. Enzymatic synthesis also contributes to cost-effectiveness. While the initial development and optimization of enzymatic processes may require investment, the long-term benefits include reduced reagent costs, decreased labor requirements, and higher yields of error-free DNA sequences. This affordability has expanded the accessibility of gene synthesis services to a broader range of researchers and industries.

In conclusion, the advent of enzymatic DNA synthesis processes is a driving force behind the Gene Synthesis market's growth. It has elevated the precision, sustainability, flexibility, and cost-effectiveness of gene synthesis, making it an indispensable tool in genetic research, biotechnology, and the development of innovative solutions across multiple sectors. As enzymatic DNA synthesis technologies continue to evolve and gain wider adoption, they are poised to shape the future of gene synthesis.

#### Technological advancements in the DNA synthesis platforms

Technological advancements in DNA synthesis platforms are serving as powerful drivers for the Gene Synthesis market, catalyzing innovation and expanding the applications of synthesized genes across various fields. These advancements are

fundamentally transforming the landscape of genetic research and biotechnology. One of the key ways in which technological advancements are driving the Gene Synthesis market is through increased efficiency and speed. Modern DNA synthesis platforms leverage innovative techniques such as microarray-based synthesis and inkjet printing, enabling the parallel synthesis of multiple DNA sequences in a high-throughput manner. This dramatically reduces the time required to generate synthetic genes, facilitating quicker research outcomes and product development in areas such as drug discovery, genetic engineering, and vaccine development. Moreover, advancements in DNA synthesis have led to increased accuracy and precision. Error rates in synthesized genes have been significantly reduced, ensuring that the genetic constructs produced are reliable and functional. This heightened fidelity is critical for applications like gene therapy and the creation of genetically modified organisms, where precise genetic modifications are essential for success.

Technological progress has also contributed to cost reduction in gene synthesis. The optimization of synthesis protocols and the development of more efficient synthesis chemistries have lowered the overall cost of producing synthetic DNA sequences. As a result, gene synthesis services have become more accessible to a wider range of researchers and organizations, fueling market growth. Furthermore, technological advancements have led to the development of user-friendly software tools for gene design and ordering. Researchers can now easily design and order custom DNA sequences through online platforms, streamlining the entire gene synthesis process. This accessibility and convenience have democratized genetic research and encouraged a broader adoption of gene synthesis services.

In conclusion, technological advancements in DNA synthesis platforms are revolutionizing the Gene Synthesis market by enhancing efficiency, accuracy, affordability, and accessibility. As these platforms continue to evolve, they are enabling breakthroughs in genetics, genomics, and biotechnology, ultimately driving innovation and expanding the frontiers of scientific discovery and commercial applications. The future of gene synthesis holds tremendous potential as technology continues to advance, opening up new possibilities for customized genetic solutions across diverse industries.

### Declining price of DNA synthesis & sequencing

The declining price of DNA synthesis and sequencing has emerged as a significant driver for the Gene Synthesis market, ushering in a new era of accessibility and innovation in genetic research and biotechnology. This trend is instrumental in

reshaping the landscape of gene synthesis and expanding its applications across various domains. First and foremost, the decreasing cost of DNA synthesis services has democratized access to custom-designed genetic constructs. Researchers, laboratories, and organizations with limited budgets can now afford gene synthesis, enabling them to pursue a wider range of scientific studies and biotechnological projects. As a result, the Gene Synthesis market has witnessed increased demand from diverse stakeholders, from academic institutions to startups and multinational corporations. In tandem with DNA synthesis, the affordability of DNA sequencing technologies has also played a crucial role. The decreasing cost of DNA sequencing enables researchers to more readily validate and analyze the synthesized genes, fostering greater confidence in experimental outcomes. This synergy between synthesis and sequencing has created a virtuous cycle, where lower costs in both domains drive greater utilization and innovation in gene synthesis projects. Moreover, the declining prices of DNA synthesis and sequencing have accelerated research and development efforts in genomics and personalized medicine. With reduced financial barriers, scientists can conduct large-scale genomic studies, uncover disease mechanisms, and develop targeted therapies. Gene synthesis is at the forefront of these advances, providing the custom genetic material necessary for such investigations.

Furthermore, as the cost of sequencing genomes continues to drop, the demand for synthesized genes for functional genomics and genome editing studies is on the rise. Researchers use synthesized genes to understand gene function, create disease models, and develop potential treatments, fueling the Gene Synthesis market's growth. In conclusion, the declining prices of DNA synthesis and sequencing are transformative drivers for the Gene Synthesis market. They enable broader access to gene synthesis services, promote innovation, and accelerate scientific discoveries in genomics, synthetic biology, and biotechnology. This affordability trend is likely to continue to shape the future of genetic research and biotechnological applications, fostering a dynamic and inclusive environment for genetic innovation..

## Key Market Challenges

### Lack of skilled professionals

The Gene Synthesis market faces a significant challenge in the form of a shortage of skilled professionals, which poses hurdles to its growth and advancement. This scarcity of expertise impacts various facets of the gene synthesis industry and has multifaceted consequences. Firstly, gene synthesis involves intricate molecular biology techniques and a deep understanding of DNA manipulation. Without a sufficient number of skilled

professionals, the industry may experience delays in project timelines, reduced efficiency, and increased risk of errors in synthesized DNA sequences. This shortage of expertise can hinder research and development efforts in areas such as drug discovery, genetic engineering, and synthetic biology, where precision and accuracy are paramount.

Moreover, the lack of skilled professionals limits the capacity for innovation and technological advancement within the Gene Synthesis market. Talented scientists and engineers are essential for driving the development of new synthesis methods, automation technologies, and software tools that enhance the efficiency and capabilities of gene synthesis platforms. Without a skilled workforce, the industry may struggle to keep pace with emerging trends and evolving customer needs. Additionally, as the demand for gene synthesis services grows across diverse industries, there is an increased need for professionals who can not only synthesize genes but also design and optimize genetic constructs for specific applications. The shortage of such specialists can constrain the market's ability to provide tailored solutions to researchers and organizations with unique genetic engineering requirements. Furthermore, the Gene Synthesis market relies on a workforce that understands and adheres to strict ethical and biosecurity standards, especially as concerns about misuse of synthesized DNA arise. Skilled professionals are essential for implementing and enforcing these standards to ensure responsible and secure use of gene synthesis services.

To address these challenges, efforts are needed to invest in education and training programs that cultivate a new generation of skilled gene synthesis professionals. Collaboration between academic institutions, industry, and regulatory bodies can help bridge the skills gap and foster a workforce capable of driving innovation and responsible use of gene synthesis technologies. In doing so, the Gene Synthesis market can overcome the obstacle posed by the shortage of skilled professionals and continue to thrive in the era of genetic advancement.

### Misuse of gene synthesis

The misuse of gene synthesis technology presents a significant challenge for the Gene Synthesis market, raising ethical, biosecurity, and regulatory concerns that can impact the industry's growth and reputation. One of the foremost challenges is the potential for synthesized genes to be used in harmful or malicious ways. As gene synthesis becomes more accessible, there is a risk that individuals or groups with nefarious intentions could request the synthesis of genes for dangerous pathogens or toxins. This misuse poses a serious biosecurity threat, as it could lead to the creation of bioweapons

or the accidental release of harmful agents into the environment. To mitigate this risk, gene synthesis providers must implement robust screening and verification processes to ensure that requested sequences do not pose biosecurity risks. However, striking the right balance between facilitating legitimate research and preventing misuse is a complex task. Additionally, ethical concerns arise from the potential misuse of gene synthesis in areas such as human cloning or the creation of genetically modified organisms with unintended consequences. The ethical implications of gene synthesis extend to issues like genetic discrimination, privacy, and consent, further complicating the landscape for the industry.

Furthermore, regulatory bodies are grappling with how to effectively oversee and govern gene synthesis activities. The dynamic nature of gene synthesis, with rapidly evolving technologies and international accessibility, makes it challenging to establish and enforce consistent regulations. Striking the right balance between facilitating scientific progress and preventing misuse is a delicate challenge for regulators. The perception of misuse and the associated ethical and biosecurity concerns can also affect the public's perception of the Gene Synthesis market. Negative perceptions may lead to increased scrutiny, stricter regulations, and public distrust, potentially hindering the industry's growth and acceptance.

Addressing these challenges requires collaboration between gene synthesis providers, researchers, regulatory bodies, and biosecurity experts to establish clear guidelines, enhance screening processes, and promote responsible practices. Ensuring that gene synthesis is used for legitimate, beneficial purposes while safeguarding against misuse is vital to the long-term sustainability and reputation of the Gene Synthesis market.

## Key Market Trends

### Growth in Personalized Medicine

The Gene Synthesis market is experiencing a significant trend driven by the growth of personalized medicine. Personalized medicine involves tailoring medical treatments and interventions to an individual's genetic makeup. This approach requires the development of custom-designed genetic constructs, which is where gene synthesis plays a pivotal role.

As personalized medicine gains prominence, the demand for synthesized genes for research, diagnostics, and therapeutic applications surges. Gene synthesis allows the creation of precise genetic tools, such as patient-specific gene therapies, gene editing

components, and diagnostic probes. These custom genetic constructs enable healthcare providers to develop treatments that are uniquely suited to an individual's genetic profile, maximizing effectiveness and minimizing adverse effects. The Gene Synthesis market is poised to benefit from this trend, as it becomes an indispensable part of the personalized medicine ecosystem. The ability to rapidly and accurately produce tailored genetic material aligns with the evolving healthcare landscape, offering hope for more effective and personalized medical solutions.

### Expanded Use in Vaccines

The Gene Synthesis market is experiencing a notable trend driven by the expanded use of synthesized genes in vaccine development. This trend is particularly significant in the context of emerging infectious diseases and the need for rapid vaccine development. Gene synthesis enables the quick and precise production of viral genetic material, making it essential for developing synthetic versions of viruses for vaccine research. During global health crises like the COVID-19 pandemic, gene synthesis played a critical role in expediting the development of vaccines by providing researchers with access to the genetic information needed to design vaccine candidates. Furthermore, the flexibility of gene synthesis allows for the engineering of vaccines with enhanced safety and efficacy. Researchers can customize vaccine constructs to optimize immune responses, ensuring better protection against infectious agents. As infectious diseases continue to pose global health threats, the Gene Synthesis market is expected to see continued growth in demand for its services to support vaccine development efforts. This trend underscores the importance of gene synthesis in the healthcare and biotechnology sectors and its contribution to public health.

### Segmental Insights

#### Method Insights

Solid-phase synthesis has dominated the gene synthesis market due to its efficiency, accuracy, and scalability. This method revolutionized gene synthesis by addressing several key challenges faced by earlier liquid-phase synthesis techniques. Firstly, solid-phase synthesis allows for the step-by-step assembly of DNA sequences on a solid support matrix. This significantly reduces the risk of errors and ensures high-fidelity synthesis as each nucleotide is added sequentially. Accuracy is paramount in gene synthesis to avoid mutations and ensure the functionality of the synthesized genes, making solid-phase synthesis highly advantageous. Secondly, solid-phase synthesis offers excellent scalability. Multiple reactions can occur simultaneously on a solid

support, allowing for the parallel synthesis of numerous DNA fragments. This high-throughput capability accelerates the gene synthesis process, making it more time-efficient and cost-effective, a crucial factor in the competitive gene synthesis market. Additionally, solid-phase synthesis is amenable to automation, enabling robotic platforms to carry out complex synthesis reactions with precision. This automation further enhances speed, accuracy, and reproducibility, making solid-phase synthesis the preferred choice for high-throughput gene synthesis services.

Furthermore, solid-phase synthesis reduces the need for purification steps between each synthesis cycle, simplifying the overall process and decreasing the chances of contamination. In summary, solid-phase synthesis has dominated the gene synthesis market because it offers a combination of accuracy, scalability, and automation capabilities that are essential for efficient and cost-effective gene synthesis services. Its ability to produce high-quality, error-free synthetic genes quickly has established it as the method of choice in the gene synthesis industry.

## End Use Insights

Academic and government research institutes have played a dominant role in the gene synthesis market due to several key factors. Firstly, these institutions are often at the forefront of scientific research and innovation. They require gene synthesis services for a wide range of research projects spanning genomics, molecular biology, biotechnology, and more. The academic environment fosters curiosity and exploration, driving the demand for custom-designed DNA sequences to support cutting-edge studies. As a result, academic and government research institutes have become significant consumers of gene synthesis services. Secondly, academic institutions and government-funded research centers frequently have access to grant funding, which they can allocate toward gene synthesis projects. This financial support enables them to undertake ambitious research endeavors that often necessitate the synthesis of specific DNA sequences. This funding advantage allows them to be active players in the gene synthesis market. Furthermore, these institutions often serve as hubs of collaboration and knowledge-sharing. They regularly engage with external partners, including gene synthesis providers, to access specialized expertise and resources. This collaboration fosters innovation and the exchange of ideas, driving the demand for gene synthesis services.

Additionally, academic and government research institutes often prioritize open-access and knowledge dissemination. They frequently publish their research findings, showcasing the value and importance of gene synthesis in various scientific fields. This

emphasis on sharing knowledge helps promote the gene synthesis market by highlighting its significance in advancing scientific understanding. In conclusion, academic and government research institutes dominate the gene synthesis market because of their substantial research needs, access to funding, collaborative nature, and commitment to advancing knowledge. Their role as leaders in scientific exploration ensures that gene synthesis remains a vital tool in pushing the boundaries of scientific discovery.

## Regional Insights

North America has emerged as a dominant force in the gene synthesis market due to a combination of factors that have fostered its growth and leadership in the industry. Firstly, North America boasts a robust and highly developed biotechnology and pharmaceutical sector. The region is home to numerous biotech companies, research institutions, and academic centers that rely heavily on gene synthesis services for a wide range of applications, from drug development to genetic engineering. This concentration of biotechnology expertise drives substantial demand for gene synthesis. Secondly, the region has a well-established ecosystem that supports innovation and entrepreneurship. The availability of venture capital, angel investors, and supportive government policies has nurtured a thriving biotech startup scene. Many of these startups focus on cutting-edge research and development projects that necessitate gene synthesis services, contributing significantly to market growth.

Furthermore, North America is at the forefront of technological advancements, including automation and artificial intelligence in gene synthesis processes. This technological edge enhances the efficiency and cost-effectiveness of gene synthesis services, attracting customers from around the world. In addition, the region benefits from a skilled workforce and a strong academic and research infrastructure. North American universities and research institutions consistently produce top-tier talent in the fields of genetics, genomics, and molecular biology, further fueling the demand for gene synthesis expertise.

Moreover, North America's regulatory environment is conducive to biotechnology research and commercialization, instilling confidence in investors and businesses. It also encourages the responsible use of gene synthesis technologies. In conclusion, North America's dominance in the gene synthesis market is a result of its strong biotech sector, innovation ecosystem, technological leadership, skilled workforce, favorable regulatory landscape, and its role as a global hub for biotechnology research and development. These factors collectively position North America as a leader in the gene

synthesis industry.

Key Market Players

OriGene Technologies, Inc.

Integrated DNA Technologies, Inc.

ProMab Biotechnologies, Inc.

Thermo Fisher Scientific, Inc.

ProteoGenix, Inc.

Biomatik USA LLC

Twist Bioscience

Boster Biological Technology

Brooks Automation, Inc.

Genscript Corp

BEIJING GENOMICS INSTITUTE

Report Scope:

In this report, the Global Gene Synthesis Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

Gene Synthesis Market, By Method:

Solid-phase Synthesis

Chip-based Synthesis

PCR-based Enzyme Synthesis

### Gene Synthesis Market, By Service:

Antibody DNA Synthesis

Viral DNA Synthesis

Others

### Gene Synthesis Market, By Application:

Gene & Cell Therapy Development

Vaccine Development

Disease Diagnosis

Others

### Gene Synthesis Market, By End Use:

Biotechnology and Pharmaceutical Companies

Academic and Government Research Institutes

Contract Research Organizations

### Gene Synthesis Market, By Region:

North America

United States

Canada

Mexico

Europe

France

United Kingdom

Italy

Germany

Spain

Asia-Pacific

China

India

Japan

Australia

South Korea

South America

Brazil

Argentina

Colombia

Middle East & Africa

South Africa

Saudi Arabia

UAE

Kuwait

Turkey

Egypt

## Competitive Landscape

Company Profiles: Detailed analysis of the major companies present in the Global Gene Synthesis Market.

## Available Customizations:

Global Gene Synthesis market report with the given market data, Tech Sci Research offers customizations according to a company's specific needs. The following customization options are available for the report:

## Company Information

Detailed analysis and profiling of additional market players (up to five).

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## **16. STRATEGIC RECOMMENDATIONS**

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