

# **Global Synthetic Biology Market: Analysis By Product Type (Oligonucleotide/Oligo Pools & Synthetic DNA, Enzymes, Cloning Technologies Kits, Xeno-Nucleic Acids and Chassis Organism), By Technology (PCR, NGS, Genome Editing, Bioprocessing and Others), By Application (Healthcare and Non Healthcare), By End Users (Biotech and Pharmaceutical Companies, Academic and Research Institutes, and Others), By Region, Size and Trends with Impact of COVID-19 and Forecast up to 2028**

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## **Abstracts**

The global synthetic biology market was valued at US\$12.97 billion in 2022, and is expected to be worth US\$46.43 billion in 2028. Synthetic biology is a multidisciplinary field of science that involves the design and construction of new biological entities, as well as the re-engineering of existing biological systems, for useful purposes. It combines principles from biology, chemistry, physics, engineering, and computer science to create artificial biological systems with specific functions or to redesign natural biological systems for improved performance. The inception of Synthetic Biology dates back to 1982 when human insulin was biosynthesized in bacteria, marking the first FDA-approved product utilizing DNA synthesis and recombinant DNA technology. In essence, SynBio involves the manipulation of biological systems to achieve specific purposes or applications, employing a diverse range of interdisciplinary life science tools and technologies.

The synthetic biology market is still emerging and largely untapped. The market is

expected to grow during the forecasted period. driven by advanced tools, rising research and development (R&D) coupled with heightened productivity, fueled by the integration of AI and data-driven methodologies. As products scale, the decreasing costs are anticipated to be a key driver for widespread adoption in the synthetic biology market. The expansion is also driven from a rising number of applications within the pharmaceutical and biotechnology sector. This surge is particularly evident in the heightened demand for complex diagnostics, such as multiplexed point-of-care testing and PCR, as well as in genome editing technologies like CRISPR and vaccine development. The demand is further expected to rise as demand for protein therapies and personalized medicine escalates along with research into synthetic pharmaceuticals and vaccines. The synthetic biology market is expected to grow at a CAGR of 23.69% over the years 2023-2028.

#### Market Segmentation Analysis:

**By Product Type:** The report identifies five segments on the basis of product type: Oligonucleotide/Oligo Pools & Synthetic DNA, Enzymes, Cloning Technologies Kits, Xeno-Nucleic Acids and Chassis Organism. Oligonucleotide/Oligo Pools and Synthetic DNA segment generated the highest revenue in 2022. In several molecular and synthetic biology applications, oligonucleotides are considered the primary point. Increasing adoption of targeted NGS, mutagenesis experiments, DNA computing, and CRISPR gene editing are the major segment drivers for the same. For instance, OligoMix is an innovative and personalized product for genomics discoveries. It synthesizes numerous sequences of oligonucleotide in massive parallel. Enzymes segment is expected to grow at the fastest CAGR during the forecasted period owing to the growing need for precise and efficient enzymatic reactions in synthetic biology applications, including gene editing and pathway optimization. Moreover, enzymes play a vital role in various industrial applications, including biofuel production and pharmaceutical manufacturing, which is further expected to propel the segment's growth.

**By Technology:** The report provides the bifurcation of synthetic biology market into five segments on the basis of technology: PCR (Polymerase Chain Reaction), NGS (Next Generation Sequencing), Genome Editing, Bioprocessing and Others. The PCR segment held the highest market share in 2022. Polymerase Chain Reaction (PCR) has emerged as one of the key technologies for the detection and analysis of specific gene sequences. The real-time PCR assays provide high sensitivity and specificity, making it the go-to method for numerous genomic studies based on PCR. This technique is widely used in various areas such as forensic research, DNA cloning, molecular

diagnostics, and genomics. Genome editing segment is expected to grow at the fastest CAGR during the forecasted period. Genome editing technologies, particularly CRISPR-Cas9, have ushered in a new era of precision in genetic engineering. CRISPR-Cas9 enables targeted modifications of DNA sequences with unparalleled accuracy. This technology holds immense potential for applications in agriculture, medicine, and biotechnology.

**By Application:** The report provides the bifurcation of synthetic biology market into two segments on the basis of application: Healthcare, and Non Healthcare. Healthcare segment dominated the market in 2022. Diagnostic based on synthetic biology provides a highly specific, sensitive, real-time, and non-invasive process for detecting infectious agents, cancer cells, and therapeutics. Researchers employ rational engineering techniques to design novel bio-sensing systems that are dynamic and constituted of a processor, sensor, and reporter. The segment is also propelled by an increase in neurological disorders such as multiple sclerosis. Non healthcare segment is expected to grow at the fastest CAGR during the forecasted period, driven by the increasing emphasis on sustainable practices and the urgent need to address environmental challenges. Companies and industries are turning to synthetic biology to develop eco-friendly solutions, driving innovation and growth in these non-healthcare applications.

**By End User:** The report identifies three segments on the basis of end users: Biotech and Pharmaceutical Companies, Academic and Research Institutes, and Others. Academic and research institutes segment is expected to grow at the fastest CAGR during the forecasted period. The adoption of synthetic biology in this segment is likely to be driven by the continuous quest for scientific knowledge and the need to develop innovative solutions. The R&D sector is considered to be capital-intensive owing to long development periods and approval cycles.

**By Region:** In the report, the global synthetic biology market is divided into four regions: North America, Europe, Asia Pacific, and ROW. North America accounted for the largest share in the global synthetic biology market in 2022. North America holds a crucial position in the global synthetic biology market, boasting a diverse ecosystem that includes numerous pharmaceutical and biotechnology giants, esteemed academic institutions, and state-of-the-art research centers. This collective environment significantly fuels the demand for synthetic biology solutions. Leading the world in biotech research, North America stands out with substantial investments in research and development (R&D), creating a substantial appetite for products related to synthetic biology. The region's robust healthcare infrastructure further amplifies this demand, especially in the fields of diagnostics and personalized medicine, where reliance on

synthetic biology is substantial.

The Asia Pacific region is expected to be the fastest-growing market. The Asia-Pacific region has experienced a notable surge in its biotechnology and life sciences sector, with countries such as China, India, Japan, and South Korea making substantial investments specifically in the field of synthetic biology. This increased focus on research and development extends particularly to areas like genomics, personalized medicine, and genetic research. The growing scientific activity in these domains has naturally led to a heightened demand for synthetic biology techniques, crucial for precisely assembling DNA strands in cutting-edge research endeavors. Moreover, the Asia-Pacific region boasts numerous prestigious academic and research institutions actively engaged in genetic and molecular biology research.

#### Market Dynamics:

**Growth Drivers:** The market has been growing over the past few years, due to factors such as rising prevalence of genetic disorders, increasing investments in synthetic biology industry, evolving landscape of the synthetic biology industry, advancements in DNA sequencing and gene synthesis technologies, rising demand for bio-based products, increase in synthetic drugs and vaccines and improvements in diagnosis and treatment. Recognized genetic disorders like Down syndrome, autism spectrum disorder, cancer, diabetes, cystic fibrosis, and sickle cell anemia are just a fraction of the 10,000 known rare diseases, impacting around 400 million people globally. While some disorders show symptoms at birth, others emerge gradually. The global burden of genetic diseases is growing. Synthetic biology offers a promising approach by allowing the engineering of biological systems to correct or mitigate genetic abnormalities. Researchers are leveraging synthetic biology techniques to develop advanced gene therapies, personalized medicine, and gene-editing technologies. These applications hold immense potential for treating genetic disorders, ranging from rare conditions to more common diseases. This facilitates informed decisions on diagnosis and treatment, acknowledging the rising need for early detection and driving the synthetic biology market.

**Challenges:** However, some challenges are also impeding the growth of the market such as stringent government regulations and guidelines, ethical considerations regarding DNA synthesis regulation and complexity of biological systems. The complexity of biological systems stands as a significant obstacle to the growth of the synthetic biology market. While synthetic biology aims to engineer living organisms for specific functions, the intricate and interconnected nature of biological processes poses

challenges. Designing organisms with precise traits involves identifying and manipulating specific DNA sequences, a task made difficult by the complexity of gene interactions. Additionally, assembling and coordinating multiple biological pathways to create modified organisms or enzymes is highly intricate.

**Trends:** The market is projected to grow at a fast pace during the forecast period, due to various latest trends such as increasing utilization of AI in synthetic biology, expansion in agriculture and food production, rising potential of synthetic biology in consumer goods and technological innovations. The increasing utilization of Artificial Intelligence (AI) stands out as a pivotal trend in the synthetic biology (SynBio) market, transforming the landscape by enhancing design, analysis, and optimization processes. AI is becoming integral to SynBio workflows, leveraging machine learning algorithms to decipher complex biological data, predict outcomes, and streamline the design of synthetic biological systems. In gene synthesis, AI accelerates the identification of optimal DNA sequences for desired traits, optimizing efficiency in the design-build-test (DBT) cycle. The synergy between AI and SynBio not only expedites research and development but also enables the exploration of vast genetic spaces that would be impractical to navigate manually.

#### Impact Analysis of COVID-19 and Way Forward:

The COVID-19 pandemic had a multifaceted impact on the synthetic biology market. Initially, disruptions in global supply chains and research laboratory closures caused delays in research projects, leading to a temporary setback in demand for synthetic biology services and products. Many research and development activities were delayed or put on hold, affecting the progress of projects and product launches. However, the pandemic also highlighted the importance of synthetic biology in addressing global health challenges. The urgent need for innovative solutions, including vaccine development and biomanufacturing processes, underscored the resilience and adaptability of the synthetic biology industry. Governments and private sectors increased investments in biotechnology to enhance preparedness for future health crisis, fostering long-term growth prospects for the synthetic biology market. Furthermore, the demand for synthetic biology solutions is anticipated to grow across various sectors, including healthcare, agriculture, energy, and industrial applications. Advances in vaccine development, gene therapies, and bio-manufacturing processes are expected to drive significant contributions to the market.

#### Competitive Landscape:

The SynBio industry is currently in its early growth stage, leading to significant fragmentation among small and medium-sized companies, each with proprietary technologies. This fragmentation is expected due to rapid technological innovation, enabling smaller companies to enter diverse SynBio markets with niche solutions. In this landscape, larger companies often utilize "tuck-in acquisitions" to enhance their position by seamlessly integrating the technology or product of a smaller company into their existing operations. This strategy allows them to fill specific gaps, complement capabilities, and gain a competitive advantage, expanding market reach or accelerating product development. Ginkgo Bioworks, for instance, has been actively employing tuck-in acquisitions to address technology gaps, particularly in the field of biotherapeutics.

The key players of the global synthetic biology market are:

Thermo Fisher Scientific Inc.  
Twist Bioscience Corporation  
Genscript Biotech Corporation  
Amyris, Inc.  
Codexis, Inc.  
Danaher Corporation (Integrated DNA Technologies)  
Ginkgo Bioworks  
Agilent Technologies, Inc  
Telesis Bio, Inc.  
Precigen, Inc

Partnerships in the SynBio (Synthetic Biology) industry play a crucial role in fostering innovation, accelerating research and development, and addressing the complex challenges inherent in this rapidly evolving field. In May 2023, Ginkgo Bioworks and Boehringer Ingelheim announced a partnership to develop therapies for hard-to-treat diseases. In April 2023, Twist Bioscience and Astellas entered their third collaboration for antibody discovery for immunotherapies.



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