

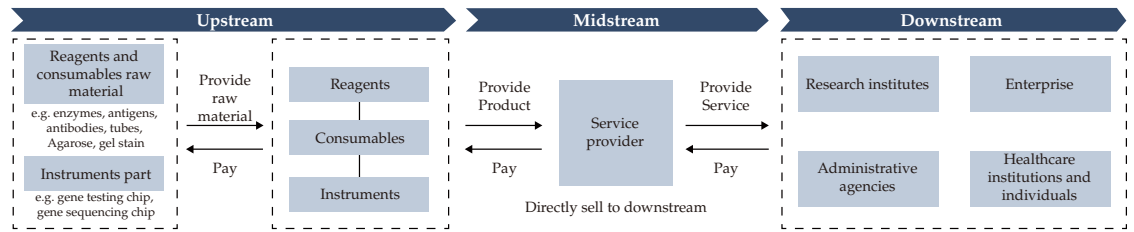
INDUSTRY OVERVIEW

Certain information and statistics set out in this section have been extracted from various official government publications, available sources from public market data providers and an independent third-party source, CIC. The report prepared by CIC and cited in this document was commissioned by us. The information from official government sources has not been independently verified by our Company, the Joint Sponsors, the [REDACTED], the [REDACTED], the [REDACTED], the [REDACTED], the [REDACTED], the [REDACTED], the [REDACTED], any of our or their respective affiliates, directors, officers, employees, agents or advisors or any other person or party involved in the [REDACTED], and no representation is given as to its accuracy, fairness and completeness. For discussion of the risks relating to our industry, see “Risk Factors.”

OVERVIEW OF LIFE SCIENCE TOOLS MARKET

Life science is one of the most significant disciplines, seeking to understand the structure, function, and behavior of living organisms at all levels of complexity. Central to both scientific research and clinical practice, life science tools encompass a broad range of instruments, reagents, and consumables that serve as the foundation for advancements in genomics, proteomics, cell biology, analytics and other cutting-edge technologies.

The value chain of life science tools forms a complex and dynamic network that comprises various participants. At the upstream, providers of instruments, reagents, and consumables supply the essential supports that enable midstream service providers to perform their work. These upstream contributions are critical in determining the efficiency and quality of the products and services that ultimately reach the market. Midstream service providers typically purchase the life science tools from upstream suppliers and use them for R&D, production, testing and other related services for downstream users, generating profit by offering these services in their intermediary role. The downstream segment consists of healthcare organizations, research institutions, regulatory agencies, and other end users who rely on the midstream service outcomes for medical treatments, scientific research, and diagnostic testing, thereby creating ongoing demand for life science tools. The following diagram sets forth an overview of life science tools value chain:

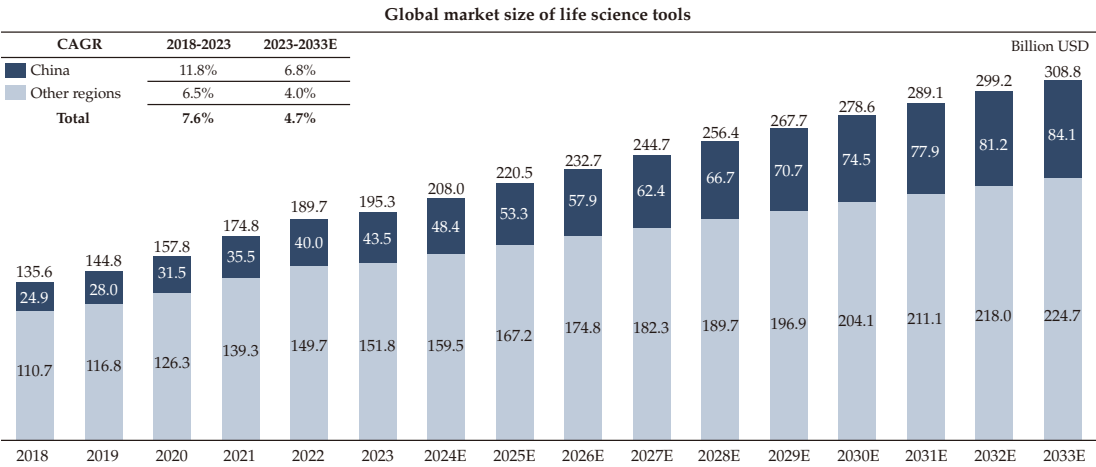


Source: CIC

INDUSTRY OVERVIEW

Global and China’s Life Science Tools Market

The global life science tools market has witnessed substantial growth in recent years, increasing from US\$135.6 billion in 2018 to US\$195.3 billion in 2023, with a CAGR of 7.6%. China’s life science tools market has seen even greater growth, increasing from US\$24.9 billion in 2018 to US\$43.5 billion in 2023, reflecting a CAGR of 11.8%. In the post-pandemic era, despite a slowdown in the overall growth rate of the life science tools market, this sector continues to present strong market potential and is expected to maintain steady growth, as driven by ongoing technological advancements, increased investment in research and development, and rising demand for innovative life science solutions across academic, clinical, and industrial sectors. By 2023, the global market size for life science tools is projected to reach US\$308.8 billion, and China’s market size is expected to reach US\$84.1 billion, representing a CAGR of 4.7% and 6.8% from 2023 to 2033, respectively. The chart below illustrates the historical and forecast size of the global and China’s life science tools markets for the periods indicated.



Note:

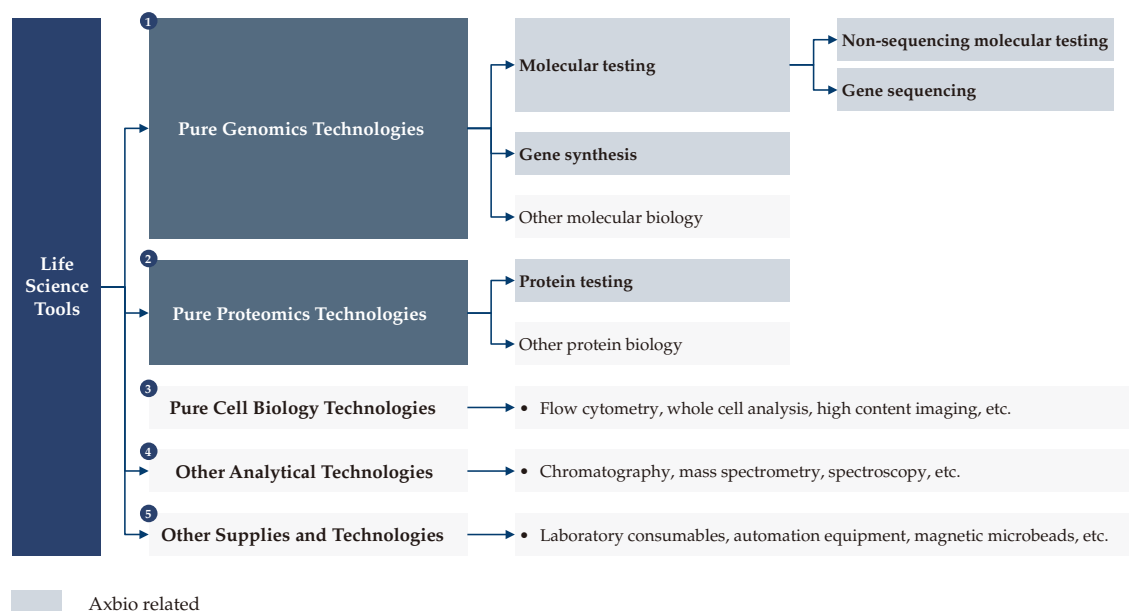
- (i) This market size excludes the impact from the COVID-19 pandemic.

Source: World Health Organization (WHO), Organization for Economic Co-operation and Development (OECD), National Bureau of Statistics of China (NBSC), General Administration of Customs of the People’s Republic of China (GACC), annual reports of listed companies, expert interviews, CIC

The life science tools market can be broadly segmented into several technical categories, each catering to distinct areas of scientific research and clinical practice. Pure genomics technologies include molecular testing — such as non-sequencing molecular testing and gene sequencing — gene synthesis, and other molecular biology technologies. Pure proteomics technologies focus on protein testing and other protein biology applications. Pure cell biology technologies encompass methods like flow cytometry, whole cell analysis, and high content imaging. The market also features other analytical technologies, including chromatography, mass spectrometry, and spectroscopy. Additionally, other supplies and technologies — such as laboratory consumables, automation equipment, and magnetic microbeads — provide essential support across all

INDUSTRY OVERVIEW

segments of life science research. The chart below illustrates such segmentation of the overall life science tools market.



Source: CIC

Growth Drivers and Future Trends of Life Science Tools Market

The growth of the life science tools market is expected to be driven and shaped by the following factors:

- National-level favorable policy support.** China has implemented a series of favorable policies to drive the growth of the life sciences tools industry, including the 14th Five-Year Plan for the Development of the Bioeconomy (《「十四五」生物經濟發展規劃》) and the 14th Five-Year Plan for National Health (《「十四五」國民健康規劃》), among others. The U.S. has also launched the National Biotechnology and Biomanufacturing Initiative in 2022, aiming to strengthen the country's position in biotechnology and life sciences manufacturing. These initiatives play a crucial role in fostering indigenous innovation and driving technological growth, creating a dynamic and competitive market landscape.
- Expansion of downstream market demand.** The growing focus on genetic research and patient needs is driving the expansion of personalized and precision medicine, which relies on advanced life science tools for quick biomarker identification and high-throughput screening, thereby fueling market demand. Beyond healthcare, the adoption of high-throughput sequencing in non-medical sectors, such as crop and livestock breeding, animal disease monitoring, and food safety testing, also contributes to the rising demand for life science tools.

INDUSTRY OVERVIEW

- ***Technological innovation and AI integration.*** Technological advancements, especially automation in high-throughput applications, spatial multi-omics and artificial intelligence, have significantly accelerated experimental processes while driving the development of more advanced life science tools and analytical platforms. In addition, the integration of automation with AI and big data analytics enables high-quality, large-scale, and highly accurate data generation and analysis, significantly enhancing efficiency, accelerating scientific discoveries, and expanding the applications of life science tools across diverse fields.
- ***Prevention and control of health emergencies.*** The emergence of sudden outbreaks, particularly the COVID-19 pandemic, has highlighted vulnerabilities in global health systems, emphasizing the need for rapid, scalable and cost-effective diagnostic solutions. This has driven a surge in demand for advanced life science tools, especially molecular diagnostic point-of-care (POCT) technologies, which play a critical role in detection, monitoring, and treatment.
- ***Transnational cooperation and technical standardization.*** Given the acceleration of collaboration between multinational pharmaceutical companies and research institutions, the standardization and regulation of life science tools have become essential to ensuring the quality and consistency of processes, driving the worldwide expansion of the life science tools market.

OVERVIEW OF MOLECULAR TESTING MARKET

Overview of Molecular Testing Technology

Molecular testing comprises a spectrum of advanced techniques designed to detect and analyze nucleic acids, including DNA and RNA, to identify genetic mutations, gene expression patterns, and epigenetic modifications at the molecular level. Depending on the underlying methods and objectives, molecular testing can generally be categorized into non-sequencing-based testing and gene sequencing. Emerged as a transformative segment within the life science tools industry, molecular testing enables precise detection and characterization of genetic, and epigenetic markers.

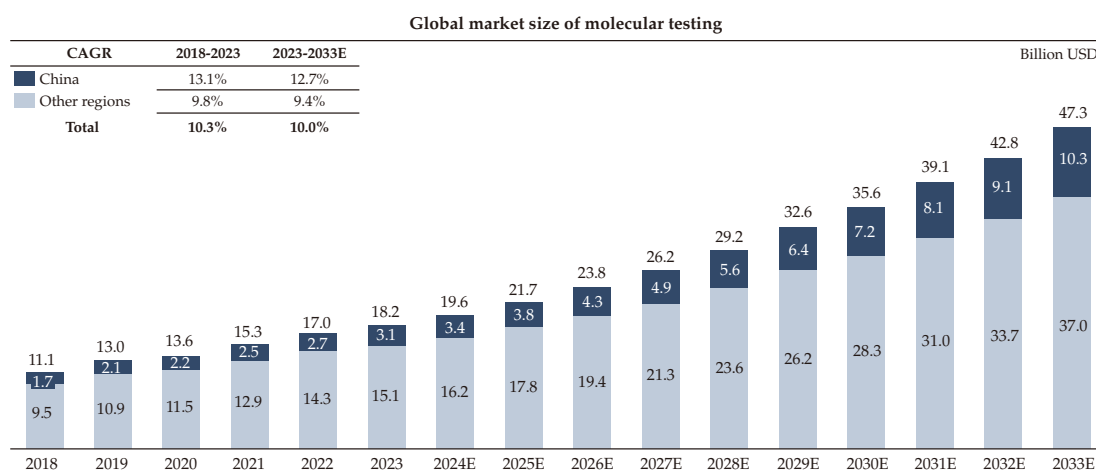
One of the most significant applications of molecular testing is in oncology management. As cancer remains a leading cause of mortality worldwide, molecular testing, especially through liquid biopsy, demonstrates immense market potential. Liquid biopsy enables the non-invasive collection of cancer biomarkers from bodily fluids such as blood or urine, allowing for the detection of circulating tumor DNA (ctDNA), circulating tumor cells (CTCs), extracellular vesicles, circulating tumor RNA (ctRNA), and exosomes. Beyond oncology, pathogen molecular testing, including PCR-based and NGS tests, plays a crucial role in identifying the genetic material of pathogens. This enables precise diagnosis and ensures targeted therapeutic interventions in the management of infectious diseases.

INDUSTRY OVERVIEW

In addition to clinical applications, consumer molecular testing has gained popularity, offering individuals insights into their genetic predisposition, potential health risks and overall wellness. Consumer molecular testing include carrier screening, genetic health risk assessments, pharmacogenetics tests, cancer predisposition screening, low-risk general wellness tests, and ancestry tests. All these consumer services are revolutionizing personal healthcare by empowering individuals to make informed decisions based on their genetic data.

Global and China's Molecular Testing Market

The broad applications of molecular testing have driven substantial growth and innovation in this sector. The global molecular testing market grew from US\$11.1 billion in 2018 to US\$18.2 billion in 2023, with a CAGR of 10.3%. The China's molecular testing market increased from US\$1.7 billion in 2018 to US\$3.1 billion in 2023, reflecting a CAGR of 13.1%. After excluding the impact of the COVID-19 pandemic which caused a temporary market distortion, both the global and China's molecular testing markets are expected to continue steady growth, reaching US\$47.3 billion and US\$10.3 billion by 2033, respectively, representing a CAGR of 10.0% and 12.7% from 2023 to 2033, respectively. The chart below illustrates the historical and forecast size of the global and China's molecular testing markets for the periods indicated.



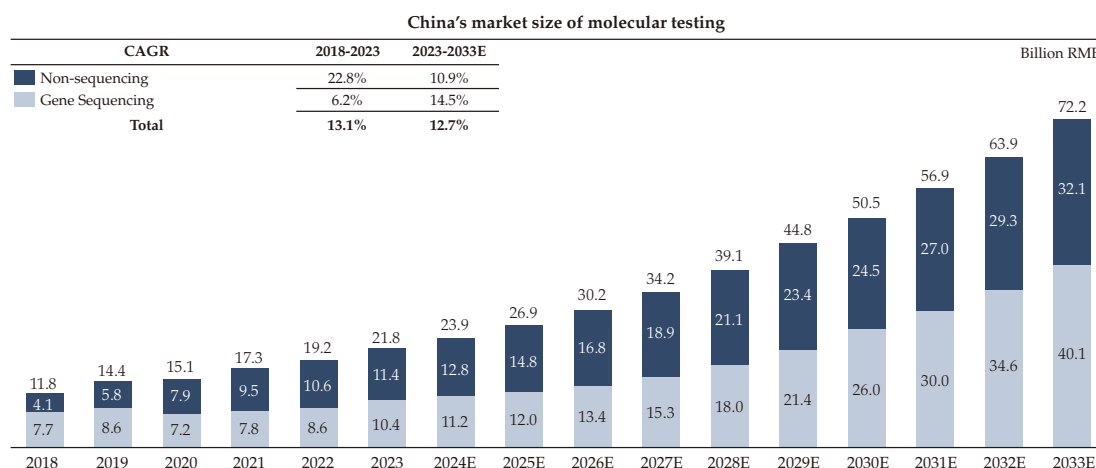
Note:

- (i) This market size includes molecular testing instruments, consumables, and clinical test kits across all applications, and excludes the impact from the COVID-19 pandemic.

Source: WHO, FDA, NMPA, annual reports of listed companies, expert interviews, CIC

INDUSTRY OVERVIEW

In China's molecular testing market, gene sequencing method was the leading segment before the COVID-19 pandemic and is projected to regain its dominant position in the next few years. The chart below illustrates a breakdown of the China's molecular testing market by molecular testing technology, including non-sequencing molecular testing and gene sequencing, for the periods indicated.



Note:

- (i) This market size includes molecular testing instruments, consumables, and clinical test kits across all applications, and excludes the impact from the COVID-19 pandemic.

Source: NMPA, Chinese Medical Association (CMA), NBSC, GACC, annual reports of listed companies, expert interviews, CIC

Entry Barriers of Molecular Testing Market

The major entry barriers for new players in the molecular testing market are set forth as follows:

- **Stringent regulatory requirements.** Molecular testing tools are subject to rigorous regulatory scrutiny in most major markets, such as the FDA, the EMA, and the NMPA. Meeting these requirements demands extensive documentation, clinical validation, and compliance with complex quality and safety standards, all of which require considerable time, expertise, and financial resources. Navigating these regulatory pathways can be particularly difficult for new entrants lacking the necessary experience or regulatory infrastructure.
- **Advanced technologies.** The development of molecular testing products relies on sophisticated technologies across multiple disciplines, including molecular biology, genomics, bioinformatics, chemistry, materials science, and engineering. This requires a high level of scientific and technical expertise, along with continuous innovation to maintain competitiveness. New entrants without a solid technological foundation or access to experienced talent may find it difficult to match the capabilities of established players, both in product performance and innovation speed.

INDUSTRY OVERVIEW

- **Market awareness and reputation.** Hospitals, laboratories, and healthcare providers tend to prefer molecular testing solutions from well-known and trusted brands with a proven track record of reliability, accuracy, and regulatory compliance. Building market recognition and earning user trust takes time, which places new entrants at a disadvantage compared to established players who already have an extensive customer base, validated products, and strong distribution networks.
- **Intensive capital investment.** Developing and commercializing molecular testing products demands substantial upfront investment in research and development, manufacturing, quality assurance, and regulatory approvals. Additionally, the sales cycle in this industry can be long, with significant time lags between development and revenue generation. While well-established companies often have the financial capacity to support sustained investment and absorb initial losses, new entrants may face considerable pressure in securing sufficient capital to fund operations through pre-commercialization and scale-up stages.

OVERVIEW OF NON-SEQUENCING MOLECULAR TESTING MARKET

Overview of Non-Sequencing Molecular Testing

The non-sequencing molecular testing relies on targeted methods that amplify or detect specific nucleic acid sequences to identify genetic variations, mutations, or the presence of pathogens, without sequencing the entire genome. The widely employed technologies in non-sequencing molecular testing include polymerase chain reaction (PCR), fluorescence *in situ* hybridization (FISH) and gene chips.

PCR is a powerful technique that utilizes DNA polymerase and primers through repeated temperature cycles to exponentially amplify target DNA sequences, enabling the production of millions of copies from a single DNA template for subsequent analysis. Depending on diverse underlying principles and detection mechanisms, PCR technology can be further classified into various subtypes, including traditional PCR, reverse transcription PCR (RT-PCR), quantitative PCR (qPCR), RT-qPCR, digital PCR (dPCR) and multiplex PCR. These variants deliver different result types — from qualitative analysis to relative and absolute quantification — with varying levels of sensitivity, specificity, and accuracy, enabling the achievement of distinct detection objectives across applications ranging from basic gene amplification to advanced tumor companion diagnostics and non-invasive prenatal screening. FISH, as another prevalent non-sequencing technology, uses fluorescent probes to bind to specific DNA sequences in tissue samples, allowing for the visualization of gene location and chromosomal abnormalities. Gene chips, also known as DNA microarrays, are used to analyze gene expression patterns across thousands of genes simultaneously by detecting hybridization between labeled DNA or RNA samples and fixed probes on a solid surface. The following chart provides a comparative analysis of these three non-sequencing molecular testing techniques in terms of their fundamental principle, technology maturity, and applications.

INDUSTRY OVERVIEW

	Principle	Technology maturity			Application
		Operation requirement	Time efficiency	Cost efficiency	
FISH	<ul style="list-style-type: none">The process of hybridizing the labeled known sequencing nucleic acid with the nucleic acid in the cell or tissue section, so as to accurately locate the specific nucleic acid.	<ul style="list-style-type: none">Low to moderate operation requirement	<ul style="list-style-type: none">Moderate time consumption with the rather cumbersome experiment process	<ul style="list-style-type: none">Low cost with mature technology	<ul style="list-style-type: none">Virus detectionDisease classification, prognosis and medication guidance of tumors
PCR	<ul style="list-style-type: none">DNA becomes single strand at high temperature and complements each other at low temperature.	<ul style="list-style-type: none">Low to moderate operation requirement	<ul style="list-style-type: none">Moderate throughputRelatively shorter experiment duration	<ul style="list-style-type: none">Relatively lower cost	<ul style="list-style-type: none">Infectious diseases diagnosisTumor early detection and companion diagnosticsGenetic diseases
Gene chip	<ul style="list-style-type: none">Known DNA sequences are integrated and hybridized with sample molecules on the same chip to obtain sample sequence information.	<ul style="list-style-type: none">High operation difficulty	<ul style="list-style-type: none">High throughputRelatively longer experiment duration	<ul style="list-style-type: none">High test cost	<ul style="list-style-type: none">High-throughput disease screening and multi-target genetic analysisNew drug development

Source: Literature review, CIC

Non-sequencing molecular testing methods can be strategically integrated to enhance analytical accuracy and multiplexing capacity. For instance, multiplex PCR-microarray testing leverages the amplification efficiency of multiplex PCR and the high-throughput screening capability of microarrays to detect multiple genetic targets in parallel, while FISH-PCR combines the sensitivity of PCR with the spatial resolution of FISH to precisely localize specific DNA sequences within cells or tissue samples.

Overview of Multiplex PCR-Microarray Testing

Multiplex PCR-microarray testing, in particular, represents a powerful integration of the amplification capability of multiplex PCR and high-throughput screening capacity of microarray technology, which offers significant economic advantages through streamlined detection processes and reduced instrumentation costs. By amplifying target DNA with PCR primers and verifying sequences using electrochemical probes, multiplex PCR-microarray testing reduces testing time and ensures accurate results. Its high throughput multiplexing ability allows simultaneous analysis of multiple targets in a single sample, saving time and resources compared to traditional methods.

With its high sensitivity and specificity, multiplex PCR-microarray can be applied across various fields. In disease diagnosis, it is used to detect infectious diseases, genetic disorders, and cancer biomarkers, offering precise and efficient results. In drug screening, multiplex PCR-microarrays can identify antibiotic resistance genes, tumor drug targets, endocrine hormone interactions, and conduct toxicological studies, thereby accelerating pharmaceutical research and development. Beyond healthcare, this technology extends its utility to genetic polymorphism studies, environmental monitoring, and agricultural breeding programs to enhance crop resilience and productivity.

This broad applicability is supported by a well-structured industrial value chain. Upstream manufacturers produce essential components such as microarray substrates, sample spotting technologies, probes, and equipment like spotters and robotic arms. Midstream companies develop diagnostic kits and instruments tailored to multiplex PCR-microarray workflows. Finally, downstream users include clinical laboratories, healthcare providers, pharmaceutical enterprises, agricultural organizations, academic research institutions, and regulatory bodies such as disease control centers and environmental monitoring agencies. This cohesive ecosystem ensures the seamless integration of multiplex PCR-microarray technology from production to application across diverse industries.

INDUSTRY OVERVIEW

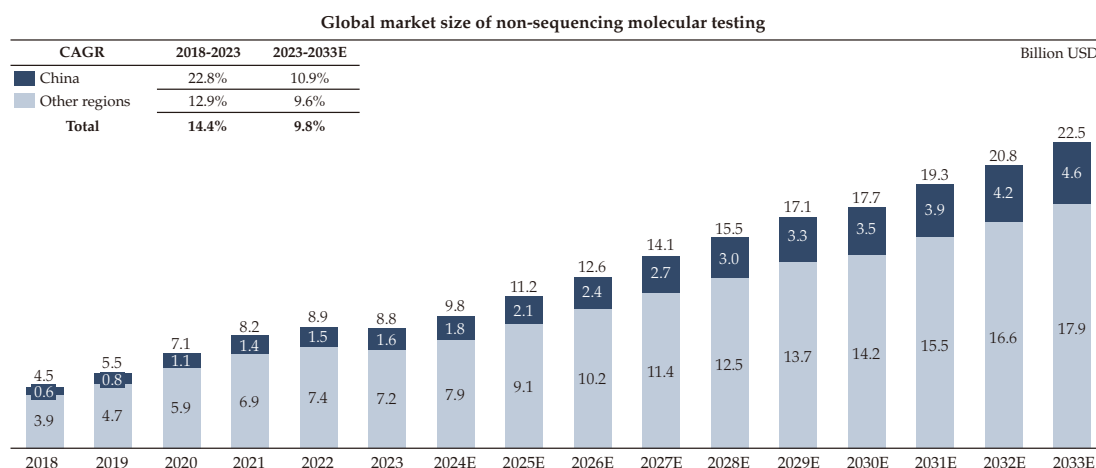
Overview of Molecular POCT

As non-sequencing molecular testing technologies evolve toward faster turnaround and broader accessibility, point-of-care testing (POCT) has emerged as a key direction, allowing molecular diagnostics to move from centralized laboratories to real-world clinical environments. POCT refers to diagnostic testing performed near or at the site of patient care, such as at the bedside or in outpatient settings, enabling immediate analysis at the point of sample collection and streamlining workflows by bypassing complex laboratory procedures while still delivering rapid and reliable results. POCT can be categorized as immunologic POCT, biochemical POCT, and molecular POCT.

Unlike immunologic and biochemical POCT, which primarily detect proteins, metabolites, or antigens, molecular POCT amplifies and analyzes DNA or RNA, allowing for early and precise disease diagnosis, even at low biomarker concentrations. As such, molecular POCT is typically best suited for applications requiring rapid, on-site diagnosis, offering convenient and immediate detection, though it may face limitations in accuracy, widespread application, and the need for high equipment and operational costs. Technologies used in molecular POCT primarily include PCR, qPCR, and multiplex PCR-microarray.

Global and China's Non-Sequencing Molecular Testing Market

The global non-sequencing molecular testing market grew from US\$4.5 billion in 2018 to US\$8.8 billion in 2023, reflecting a CAGR of 14.4%, which is expected to reach US\$22.5 billion in 2033, with a CAGR of 9.8%. China's non-sequencing molecular testing market increased from US\$0.6 billion in 2018 to US\$1.6 billion in 2023, reflecting a CAGR of 22.8%, which is expected to reach US\$4.6 billion in 2033, with a CAGR of 10.9%. The chart below illustrates the historical and forecast size of the global and China's non-sequencing molecular testing markets for the periods indicated.



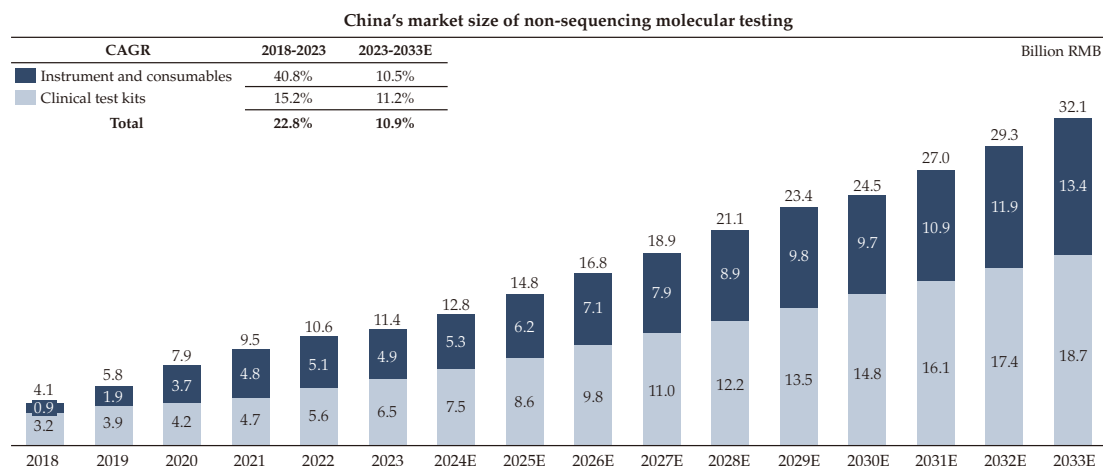
Note:

- (i) This market size includes non-sequencing molecular testing instruments, consumables, and clinical test kits across all applications, and excludes the impact from the COVID-19 pandemic.

Source: WHO, FDA, NMPA, annual reports of listed companies, expert interviews, CIC

INDUSTRY OVERVIEW

The chart below further illustrates a breakdown of the China’s non-sequencing molecular testing markets by product type, including instruments and consumables and clinical test kits, for the periods indicated.



Note:

- (i) This market size excludes the impact from the COVID-19 pandemic.

Source: NMPA, CMA, NBSC, GACC, annual reports of listed companies, expert interviews, CIC

Competitive Landscape of Non-Sequencing Molecular Testing Instrument and Consumables Market

The global non-sequencing molecular testing instrument and consumables market is highly competitive and fragmented, with numerous multinational corporations and regional players vying for market share. The key players include bioMérieux, Bio-Rad Laboratories, Danaher Corporation, Qiagen N.V., and Roche Diagnostics, leveraging their broad product portfolios, ongoing innovation, and global distribution networks to maintain their competitive positions. China’s non-sequencing molecular testing instrument and consumables market mirrors global trends in fragmentation, with both multinational corporations (such as bioMérieux, Bio-Rad Laboratories, Danaher Corporation, Qiagen N.V., and Roche Diagnostics) and a rapidly growing cohort of domestic players (such as Axbio and Daan Gene) launching new products and expanding their portfolios.

INDUSTRY OVERVIEW

Among the existing non-sequencing molecular testing products utilizing multiplex PCR-microarray technologies, a majority of them are based on fluorescence microarray detection and few opt for electrochemical microarray detection which offers higher sensitivity and specificity, greater multiplexing capacity, lower costs, simpler and more compact instrumentation, and a streamlined workflow compared to fluorescence-based systems. As of the Latest Practicable Date, there were only two electrochemical microarray analyzers approved by the NMPA or its local counterparts, including our Core Product AxiLona EL-100. The chart below illustrates the competitive landscape of China's multiplex PCR microarray analyzer market.

Analysis of China's competitive landscape of multiplex PCR microarray analyzer market

Indicator	Multiplex PCR + Fluorescence Microarray Detection	Multiplex PCR + Electrochemical Microarray Detection
Sensitivity	• ≥ 200 Copies/mL	• Can be as low as 100 Copies/mL
Specificity	• Relatively low (only specific primers for amplification)	• >99.9% (The combination of specific primers for amplification and highly specific probes for hybridization significantly improves specificity)
Number of Detectable Targets	• Usually 4-6 targets, limited by tube separation (a single tube generally allows for 4 targets; using multiple tubes increases nucleic acid usage, cost, and operational complexity)	• >50 targets
Sample Throughput per Unit Time	• Relatively low (based on a 4-channel device, multiplex detection requires tube separation, with each tube detecting up to 4 items; therefore, the number of samples detectable per unit time is significantly reduced)	• High (If standard PCR is used for amplification, detection throughput is 3-4 times higher than fluorescent quantitative PCR; if paired with front-end processing platforms, detection throughput can exceed that of fluorescent quantitative PCR by over 100 times)
Instrument Cost	• High, complex optical components lead to high instrument cost	• Low, no complex optical components, only 1/10 the cost of a fluorescent quantitative PCR instrument
Reagent Cost	• Relatively high (signal detection requires multiple fluorescent-labeled probes like Taqman probes, increasing production cost)	• Low, about 1/2 the cost of fluorescent detection reagents (only one electrochemical group is needed per signal detection; thus only one type of label is needed, resulting in lower production cost)
Convenience	• Relatively large in size and weight	• Compact and convenient
Number of NMPA approval product	• 76	• 2
Key Players	• CapitalBio • Afymetrix • Agilent	• Axbio • Daan Gene

Source: NMPA, public information, literature review, CIC

Growth Drivers of Non-Sequencing Molecular Testing Market

The growth of the non-sequencing molecular testing market is expected to be driven by the following factors:

- ***Aging population and chronic disease burden.*** With a globally aging population, the prevalence of age-related chronic diseases is steadily rising. Conditions such as cardiovascular disease, diabetes, and neurodegenerative disorders require continuous testing and health monitoring. As awareness and focus on chronic disease management grow, the demand for non-sequencing molecular testing will continue to rise, driven by its ability to enable early detection, track disease progression, and optimize treatment.
- ***Rising incidence of infectious disease and cancer.*** The growing burden of infectious diseases like AIDS and hepatitis underscores the urgent need for improved prevention, screening, and treatment. Non-sequencing molecular testing enables rapid pathogen identification, enhancing patient outcomes and reducing transmission risks. Additionally, the growing cancer incidence is driving early screening and MRD monitoring. PCR allows ultra-early detection of tumor-specific biomarkers in blood, shifting cancer prevention to proactive intervention, and detects tumor traces earlier than imaging, guiding personalized treatment and improving outcomes.

INDUSTRY OVERVIEW

- ***Growing demand for cost-effective diagnostics.*** Advances in domestic manufacturing have reduced the costs of non-sequencing molecular testing instruments and reagents, making diagnostics more affordable. Furthermore, its widespread application in primary care, disease monitoring, and early detection aligns with efforts to improve diagnostic accessibility within China's hierarchical healthcare system.
- ***Expanding applications for rapid detection.*** Non-sequencing molecular testing is becoming increasingly important in food safety and traceability, addressing global food security challenges with its speed, sensitivity, and cost-effectiveness. Additionally, the growing number of older pregnant women and heightened awareness of prenatal health have made non-invasive prenatal testing (NIPT) a crucial part of modern prenatal screening, with non-sequencing methods offering significant advantages in this area.
- ***Technological Advancement.*** The integration of AI with biochip technology represents a powerful growth driver in molecular diagnostics. AI excels at analyzing the vast datasets generated by biochips, uncovering subtle patterns and biomarkers that traditional analytical methods often overlook. In turn, biochips deliver standardized, large-scale data inputs essential for AI algorithms. This synergistic relationship enables rapid, high-throughput processing of complex biological samples, significantly reducing testing turnaround times and lowering overall costs in molecular diagnostics. The convergence of these technologies is poised to revolutionize clinical testing workflows and expand market opportunities.
- ***Policy support.*** The Chinese government actively promotes non-sequencing diagnostic technologies through favorable policies. For example, the 14th Five-Year Plan for Medical Equipment Industry Development (《「十四五」醫療裝備產業發展規劃》) emphasizes advancements in *in vitro* diagnostics, high-throughput intelligent testing, and multifunctional diagnostic tools, and the NMPA has also streamlined approvals for innovative diagnostic products, accelerating market entry.

Future Trends of Non-Sequencing Molecular Testing Market

The non-sequencing molecular testing market is expected to be shaped by the following factors:

- ***Advancing personalized medicine.*** Non-sequencing technologies, particularly those designed for high-throughput and point-of-care diagnostics, will be central to the progress of personalized medicine. These technologies allow for the rapid and accurate identification of genetic variations and microbial compositions, which are crucial for determining the most effective treatment options.

INDUSTRY OVERVIEW

- ***AI-driven POCT.*** The integration of AI in POCT will drive the miniaturization and automation of non-sequencing tests. AI-powered microfluidic devices will autonomously manage fluid dynamics and enhance the reliability of immunoassays, improving diagnostic accuracy and convenience. This trend will enable faster, more efficient testing, making non-sequencing technologies even more accessible and effective.

OVERVIEW OF GENE SEQUENCING MARKET

Overview of Gene Sequencing Technology

Gene sequencing technology refers to the methods used to determine the order of nucleotides in a DNA or RNA molecule, which plays a crucial role in genomics, enabling the analysis of genetic information for applications in research, diagnostics, and other fields. As gene sequencing technology has advanced, a range of methods has emerged, each with unique features and capabilities. Key parameters that define the performance of these technologies include read length, detection methods, and sequencing methods.

Read Length: Long-Read vs. Short-Read Sequencing

The read length of a gene sequencer refers to the number of DNA base pairs that can be sequenced continuously in a single read, representing a vital technical feature of gene sequencing technologies. Short-read sequencing technologies, such as those offered by Illumina, deliver high-throughput, cost-effective, and highly accurate sequencing of short DNA fragments. However, they encounter difficulties in handling complex genomic regions, especially those with repetitive sequences, and are limited in their ability to detect structural variants and assemble intricate genomic regions. In contrast, long-read sequencing technologies, such as those from Pacific Biosciences and Oxford Nanopore, can sequence longer fragments, even up to several kilobases. Longer reads provide superior accuracy in assembling complex genomic regions, though they come at a higher cost and lower throughput.

Detection Method: Fluorescence-Based vs. Electrochemical-Based Detection

Fluorescence-based detection identifies DNA sequences by measuring the emission of light from fluorescently tagged nucleotides as they pass through a detection system. While this method offers high sensitivity, it also presents several limitations, such as restricted read lengths and variable signal detection sensitivity. Furthermore, the use of fluorescence can damage critical biochemical components, potentially compromising sequencing accuracy and reducing the longevity of the reaction.

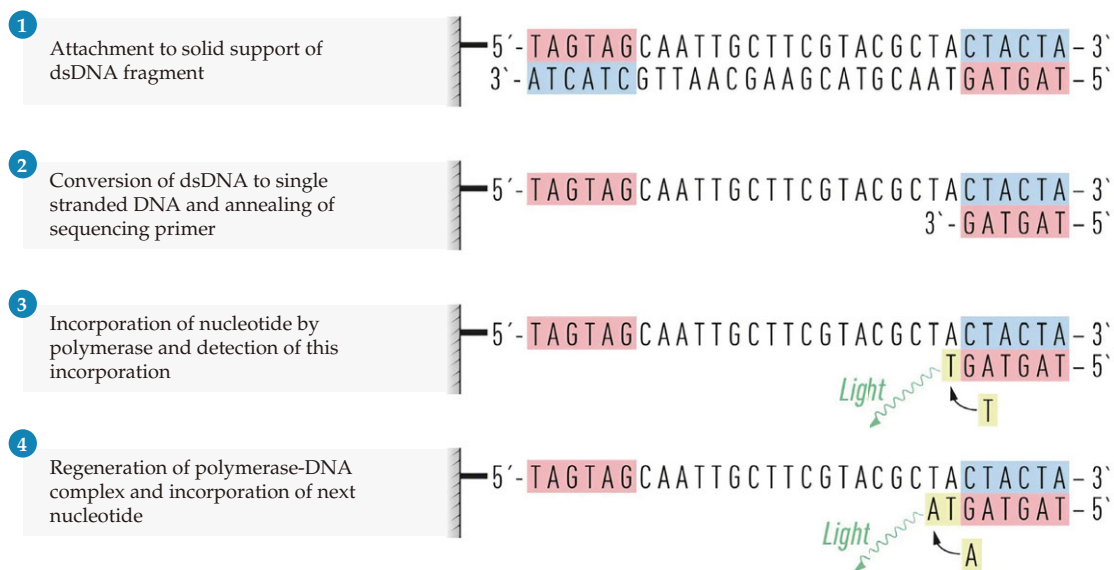
INDUSTRY OVERVIEW

Electrochemical-based detection, on the other hand, identifies DNA sequences by measuring changes in ionic current as nucleotides pass through a nanopore, with each nucleotide type tagged with a unique polymer that creates a distinct current blockage pattern. This method eliminates the need for costly optical components and fluorescent labels, thus reducing both instrument and reagent costs. It also allows for faster, real-time data processing, offering the potential for more compact, reliable, and portable systems, making it ideal for miniaturization and integration into mobile devices.

Sequencing Method: Direct Sequencing vs. Sequencing by Synthesis

Direct sequencing of native DNA bypasses the need for amplification or chemical modification, enabling faster sequencing of DNA and RNA. However, this approach may result in lower accuracy and higher error rates.

In contrast, sequencing by synthesis (SBS), widely commercialized by Illumina as the dominant NGS platform, determines DNA sequences by detecting the sequential incorporation of nucleotides using engineered DNA polymerase. Each DNA fragment is independently bound to sites on the flow cell, enabling parallel sequencing of millions of fragments simultaneously. By following the natural DNA replication process and leveraging the base-pairing specificity of polymerase, SBS offers high accuracy and simplifies the workflow by eliminating the need for multiple cycles of reagent addition and washing. The chart below illustrates the SBS workflow.



Source: Literature review, CIC

INDUSTRY OVERVIEW

Type of Gene Sequencing Technology

Over the years, various gene sequencing technologies have been developed, each offering unique features in terms of accuracy, speed, and application. The below table illustrates the capabilities, advantages and limitations of the four main types of gene sequencing, including Sanger sequencing, next-generation sequencing (NGS), single molecular sequencing, and electrochemistry long-reading next-generation sequencing (EL-NGS).

Technology	Capabilities	Advantages	Limitations
Sanger sequencing	<ul style="list-style-type: none">High precision (error rate 0.001-0.01%)Moderate sequencing length (1kbp)Low throughput (<1kb)cDNA sequencing method	<ul style="list-style-type: none">Fast and cost-effective for low target numberWell-established workflowSimple data analysis	<ul style="list-style-type: none">Low sensitivity (15-20% detection limit)Low discovery powerLow scalability due to increasing sample input requirements
NGS	<ul style="list-style-type: none">Sequencing length 50-300bp0.1% error rateLow cost per base, high cost per run	<ul style="list-style-type: none">Multiplexing/sample pooling to lower unit costHigh throughput	<ul style="list-style-type: none">Complex data analysisHigher error rate than SangerShort read
Single molecule sequencing	<ul style="list-style-type: none">Fluorescent signal-basedMedium throughputSequencing length 10k-100kbp <ul style="list-style-type: none">Electrical signal-basedUltra-long read length (>100kb)	<ul style="list-style-type: none">Extremely high accuracy (<0.01%) <ul style="list-style-type: none">Really (ultra-) long readsPortability	<ul style="list-style-type: none">High error rate at single pass (~15%)Expensive sequencer <ul style="list-style-type: none">High overall error rate (~10%)Systematic errors
EL-NGS	<ul style="list-style-type: none">Electrical signal-based1 million individual sensing channels; targeting 10 million individual sensing channels in the futureHigh throughput 100Gb; 1,000Gb expected in the future	<ul style="list-style-type: none">Long read capabilitiesHigh sequencing accuracyScalable to high throughputExtremely low cost per samplePortable and low instrument cost	<ul style="list-style-type: none">Require advanced algorithms for signal/data processing

Source: Literature review, CIC

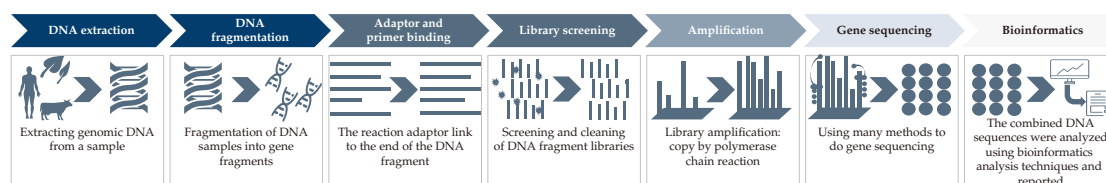
Among all gene sequencing technologies, EL-NGS stands out as a transformative DNA sequencing technology, delivering exceptional all-around performance by combining the benefits of long-read sequencing, electrochemical-based detection, and SBS with nanopore technology. Built on specially designed nucleotides with polymer tags that produce distinct electrical signals as they pass through nanopores, EL-NGS enables real-time detection of nucleotide incorporation during DNA synthesis, offering both speed and precision while overcoming key limitations of traditional methods. By eliminating the need for optical detection systems and complex sample preparation, EL-NGS simplifies the process and reduces costs. Additionally, its scalable electronic sensors enable higher throughput, further lowering costs. With the potential to revolutionize genome analysis, EL-NGS is poised to advance a wide range of applications, from basic research to clinical diagnostics, and drive progress in personalized medicine and genetic research.

Workflow of Gene Sequencing Technology

The fundamental principles of gene sequencing involve extracting sequence information from DNA samples, capturing signals via electrochemical reactions or optical detection techniques, and processing the resulting data through computer analysis. Depending on the technology employed, additional steps such as DNA fragmentation in next-generation sequencing or DNA amplification in polymerase chain reaction-based sequencing methods may be necessary to optimize the sequencing process.

INDUSTRY OVERVIEW

The below chart illustrates the typical workflow of NGS, including DNA extraction, DNA fragmentation, adaptor and primer binding, library screening, amplification, gene sequencing and bioinformatics.



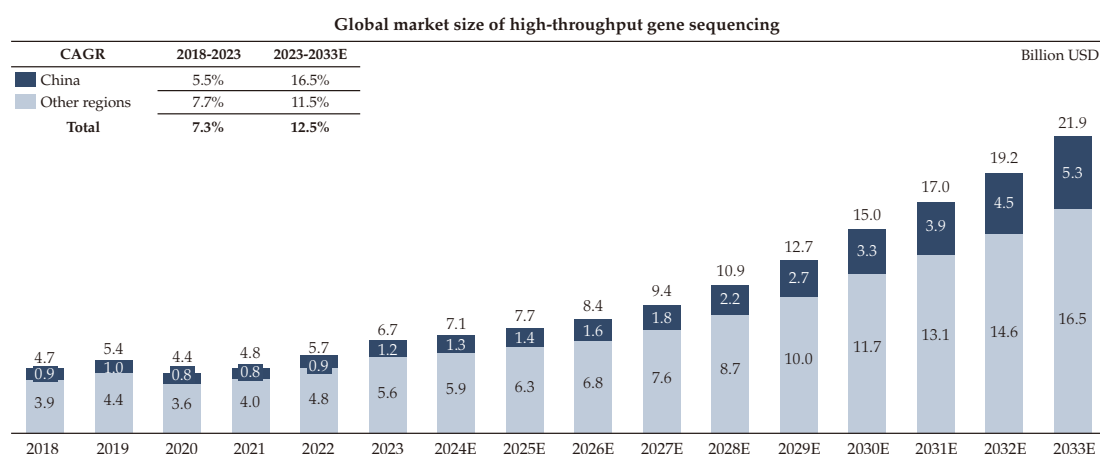
Source: Literature review, CIC

Global and China's High-Throughput Gene Sequencing Market

Recent advances in both global and China's gene sequencing markets have been largely driven by the adoption of next-generation sequencing technologies. Traditional Sanger sequencing, while precise, is significantly limited by its low throughput, generating only a single sequence per reaction. This makes it impractical for large-scale genomic applications where high volume and efficiency are essential. As demand for long-read, more cost-effective, and more comprehensive genomic analysis grows, high-throughput sequencing platforms have emerged as the backbone of this progress, enabling the parallel sequencing of millions of DNA molecules and significantly expanding the scale and efficiency of genomics research and clinical applications.

The high-throughput gene sequencing segment has experienced robust growth in recent years and is projected to accelerate further, positioning itself as one of the most dynamic drivers within the broader gene sequencing landscape. The global high-throughput gene sequencing market grew from US\$4.7 billion in 2018 to US\$6.7 billion in 2023, reflecting a CAGR of 7.3%, which is expected to reach US\$21.9 billion in 2033, with a CAGR of 12.5%. China's high-throughput gene sequencing market increased from US\$0.9 billion in 2018 to US\$1.2 billion in 2023, reflecting a CAGR of 5.5%, which is expected to reach US\$5.3 billion in 2033, with a CAGR of 16.5%.

The chart below illustrates the historical and forecast size of the global and China's high-throughput gene sequencing markets for the periods indicated.



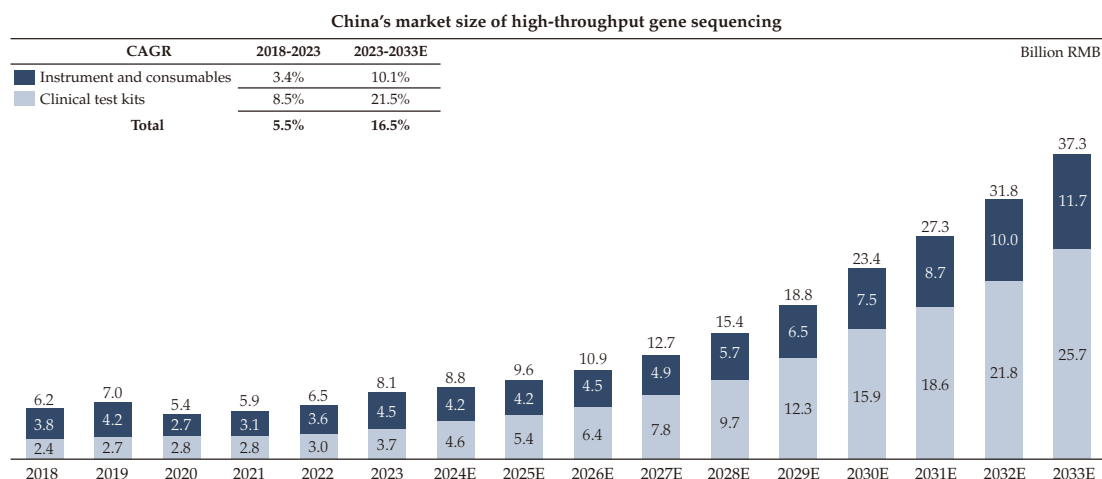
Note:

- (i) This market size includes high-throughput gene sequencing instruments, consumables, and clinical test kits (excluding the products employing Sanger sequencing technologies) across all applications, and excludes the impact from the COVID-19 pandemic.

Source: WHO, FDA, NMPA, annual reports of listed companies, expert interviews, CIC

INDUSTRY OVERVIEW

The chart below illustrates a breakdown of the China’s high-throughput gene sequencing market by product type, including instrument and consumables and clinical test kits, for the periods indicated.

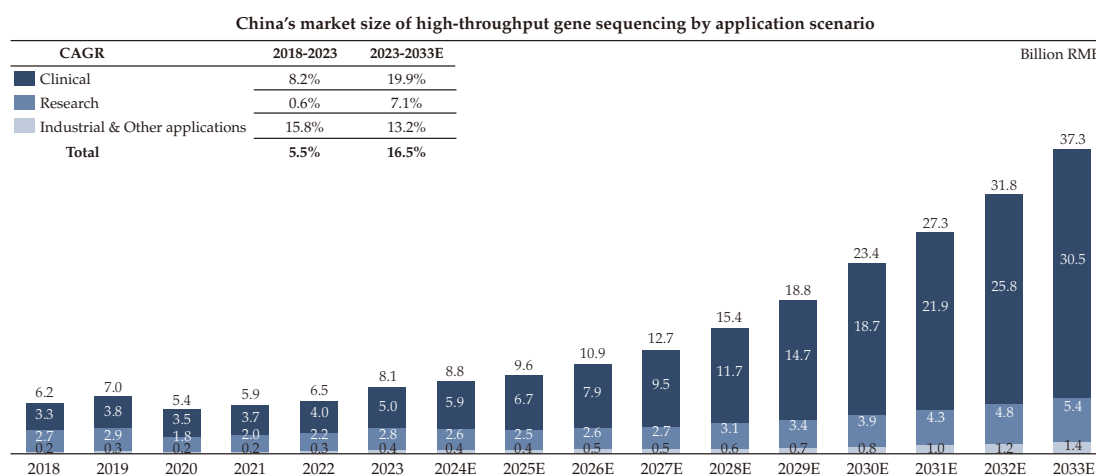


Note:

- (i) This market size excludes the impact from the COVID-19 pandemic.

Source: NMPA, National Health Commission (NHC), NBSC, GACC, annual reports of listed companies, expert interviews, CIC

The chart below illustrates a breakdown of the China’s high-throughput gene sequencing market by application scenario for the periods indicated.



Note:

- (i) This market size includes high-throughput gene sequencing instruments, consumables, and clinical test kits (excluding the products employing Sanger sequencing technologies) across all applications, and excludes the impact from the COVID-19 pandemic.

Source: Annual reports of listed companies, expert interviews, CIC

INDUSTRY OVERVIEW

Competitive Landscape of High-Throughput Gene Sequencing Instrument and Consumables Market

The global high-throughput gene sequencing instrument and consumables market is highly concentrated and dominated by a few multinational biotechnology companies. In 2023, the top five players accounted for an aggregate market share of 96.2%, with Illumina alone capturing a significant share of 72.1%, in terms of their respective revenue in the same year. The table below sets forth the top five players in the global high-throughput gene sequencing instrument and consumables market and their respective market shares by revenue in 2023.

Company	Market share (%)
Illumina	72.1%
Thermo Fisher Scientific	9.5%
MGI	6.7%
Pacific Biosciences	4.0%
Oxford Nanopore Technologies	3.9%

Notes:

- (i) Market share represents each company’s revenue from gene sequencing instruments, compatible consumables, and after-sales maintenance service in the global high-throughput gene sequencing instrument and consumables market.

Source: Annual reports of listed companies, JPM conference, expert interviews, CIC

The competitive landscape of China’s high-throughput gene sequencing instrument and consumables market shares the same pattern as the global market, with similar dominant players and level of market concentration. In 2023, the top five players collectively secured 96.9% of the market share by revenue in the same year. While Illumina leads both globally and in China, the market share distribution in China is more balanced than that globally due to MGI’s significant presence as a prominent local player. As of the Latest Practicable Date, 36 high-throughput gene sequencing instruments by 23 players had been approved by the NMPA or its local counterparts. The table below sets forth the top five players in China’s high-throughput gene sequencing instrument market and their respective market shares by revenue in 2023.

INDUSTRY OVERVIEW

Company	Market share (%)
Illumina	54.2%
MGI	32.6%
Thermo Fisher Scientific	4.3%
Oxford Nanopore Technologies	3.2%
Pacific Biosciences	2.6%

Notes:

- (i) Market share represents each company’s revenue from gene sequencing instruments, compatible consumables, and after-sales maintenance service in China’s high-throughput gene sequencing instrument and consumables market.

Source: Annual reports of listed companies, JPM conference, expert interviews, CIC

Growth Drivers of Gene Sequencing Market

The growth of the gene sequencing market is expected to be driven by the following factors:

- **Continuous technological advancements.** Rapid advancements in sequencing technologies have greatly enhanced accuracy, speed, and cost-effectiveness in this sector, reducing both time and costs compared to traditional methods. As more affordable sequencing platforms emerge, healthcare professionals can adopt genetic testing on a larger scale, fueling the continued growth of the gene sequencing market.
- **Regulatory and investment support.** Governments and regulatory bodies are increasingly recognizing the importance of genetic testing in healthcare. For example, China’s 14th Five-Year Plan (《「十四五」規劃》) highlights gene sequencing as a strategic industry, and the 21st Century Cures Act in the U.S. supports genomic technology development through policies and funding. Additionally, significant investments from governments, private organizations, and academic institutions are advancing genomics, making sequencing more precise, affordable, and innovative.
- **Rising demand for personalized medicine.** Personalized medicine, which customizes treatment based on an individual’s genetic profile, is emerging as a major force in healthcare. By enabling the comprehensive identification of genetic variants in both monogenic and polygenic diseases, gene sequencing technologies are playing a critical role in this shift. Therefore, the rising demand for personalized medicine is driving the adoption of these technologies and fueling market expansion.

INDUSTRY OVERVIEW

- **Expansion of POCT market.** The rapid expansion of the POCT market is driving the adoption of portable, cost-effective, and efficient sequencing technologies across diverse healthcare settings. This growth is accelerating the integration of gene sequencing into clinical practice, enabling faster disease detection, more precise treatment decisions, and broader applications in precision medicine.

Future Trends of Gene Sequencing Market

The gene sequencing testing market is expected to be shaped by the following factors:

- **Expansion on bioinformatics.** Leading companies have expanded their operations beyond sequencing equipment to encompass reagents, consumables, and bioinformatics tools, aiming for greater control over the supply chain. In particular, bioinformatics plays a crucial role in interpreting the vast volumes of sequencing data, and as sequencing technology advances, the ability to extract meaningful insights from raw genetic data is becoming a key competitive advantage.
- **Massive data set and the "Gene + Cloud" solution.** The enhanced accessibility of gene sequencing due to the cost reduction, as well as the widespread adoption of NGS and advanced omics technologies drive the production of massive datasets. Considering the vast amounts of data generated by gene sequencing, plenty of cloud service providers create one-stop gene sequencing solutions for customers. Meanwhile, some leading sequencing companies select to increasingly invest in cloud-based platforms to integrate their sequencing services with computational tools.
- **Further adoption of EL-NGS.** EL-NGS excels in resolving repetitive genetic regions, such as centromeres and telomeres, which are difficult to sequence with traditional methods. With its electrochemical detection mechanism, enhanced throughput, and the elimination of costly optical components, EL-NGS significantly reduces sequencing costs, making it an attractive option for advancing genome analysis. The integration of biochip technology with EL-NGS systems offers significant advantages in miniaturization, paving the way for portable sequencing devices that maintain high accuracy while substantially reducing sequencing costs.
- **Integration of AI into gene sequencing.** The AI capabilities, supported by machine learning models, deep learning algorithms, AI-powered quality control systems, predictive analytics, and natural language processing, will fundamentally transform the gene sequencing field. This integration will enhance accuracy, reduce errors, and optimize sequencing processes.

INDUSTRY OVERVIEW

OVERVIEW OF PROTEIN TESTING MARKET

Overview of Protein Testing Technology

Protein testing technology refers to a range of techniques used to measure and analyze protein levels in biological samples, such as blood, plasma, serum, or urine, providing valuable insights into the underlying mechanisms of diseases and enabling diagnosis with higher accuracy and personalized treatment strategies. Drawing on years of extensive research in the field of proteomics, a range of protein testing methods has emerged to assess a patient’s protein levels and inform appropriate treatment strategies. Widely utilized techniques include enzyme-linked immunosorbent assay (ELISA), chemiluminescence, immunofluorescence, Western blot, mass spectrometry, and protein-microarray. The following table provides an overview of the principles and a comparative analysis of the key parameters of these protein testing methods.

Classification	ELISA	Chemiluminescence	Immunofluorescence	Western Blot	Mass Spectrometry	Protein-microarray
Working principles	Antigens or antibodies are immobilized on polystyrene microplates. Specimens are added, and the presence, absence, or quantity of the target antigen or antibody is indicated by the color development from enzyme-labeled substances	Chemiluminescent substances, catalyzed and oxidized, form excited intermediates that emit photons (hv) upon returning to ground state. This light is measured by a luminometer. In immunoassays, these substances are labeled on antigens or antibodies, or enzymes act on chemiluminescent substrates	Based on antigen-antibody reactions, known antigens or antibodies are labeled with fluorescent groups to detect their counterparts in cells or tissues. Fluorescence microscopy visualizes their location, determining nature and localization. Quantitative techniques measure content	Western Blot uses PAGE to separate proteins by size, transferring them to a solid-phase carrier (e.g nitrocellulose membrane). Proteins, serving as antigens, react with primary antibodies and enzyme- or isotope-labeled secondary antibodies for detection	Mass spectrometry for protein analysis involves sample preparation, protein digestion with trypsin, ionization using MALDI or ESI, and determining peptide mass-to-charge ratios in a mass spectrometer. The spectra are then compared to databases for protein identification	Protein-microarrays work by immobilizing proteins or antibodies on a solid surface, then detecting target proteins through specific binding interactions, without using labeled probes for visualization
Applications	Detection of the concentration and physicochemical properties of antigens or antibodies	Detection of the presence of antibodies and inference of an unknown antibody (or antigen) based on a known antigen (or antibody)	Visualize proteins in cells/tissues for disease diagnosis and pathophysiology understanding	Identifies specific proteins in complex mixtures, providing semi-quantitative estimates. It is used in medical diagnostics, such as HIV and BSE testing	Mass spectrometry in clinical protein detection identifies and quantifies proteins, aiding in disease diagnosis and biomarker discovery	High-throughput detection of proteins and autoantibodies acquires biological info in samples with high accuracy

Item	ELISA	Chemiluminescence			Immunofluorescence	Western Blot	Mass Spectrometry	Protein-microarray
		Indirect	Direct	Electrochemical				
Sensitivity	10 ⁻¹¹ mol/L	10 ⁻¹⁶ ~10 ⁻²² mol/L	10 ⁻¹⁶ ~10 ⁻²² mol/L	10 ⁻¹⁶ ~10 ⁻²² mol/L	10 ⁻¹² mol/L Susceptible to interference	100~1,500 µg/mL	10 ⁻⁹ ~10 ⁻¹⁶ mol/mL	10 ⁻¹³ mol/L
Qualitative/ Quantitative	Qualitative/ Quantitative	Quantitative	Quantitative	Quantitative	Qualitative/ Quantitative	Qualitative/ Quantitative	Qualitative/ Quantitative	Qualitative/ Quantitative
Quantitative Accuracy								
Time-consuming								
Cost								
Operative Difficulty Index								
Situation of application	Gradually being replaced by automated chemiluminescent devices	Widely used in labeled immunoassays, becoming a mainstream immunodiagnostic technique	Widely used in labeled immunoassays, becoming a mainstream immunodiagnostic technique	Roche patented technology, patent expires in 2016	Few applications at present	Widely used in clinical settings for the detection and analysis of specific proteins	Few applications at present	Neurological diseases – Alzheimer’s, Dementia, Parkinson’s, Cardio – early detection of heart attack

Source: Literature review, CIC

As a specialized approach within the broader protein testing segment, protein sequencing is the process of determining the amino acid sequence of all or part of a protein or peptide, which has become an essential tool to advance both medicine and biology. In medical research, protein sequencing, especially the precise analysis of protein primary structure, enables the development of protein-based antibodies to fight viral and bacterial infections. In industrial biotechnology, protein sequencing helps identify key protein modification sites, design efficient enzymes, and optimize biosynthetic pathways, boosting process efficiency and profitability.

INDUSTRY OVERVIEW

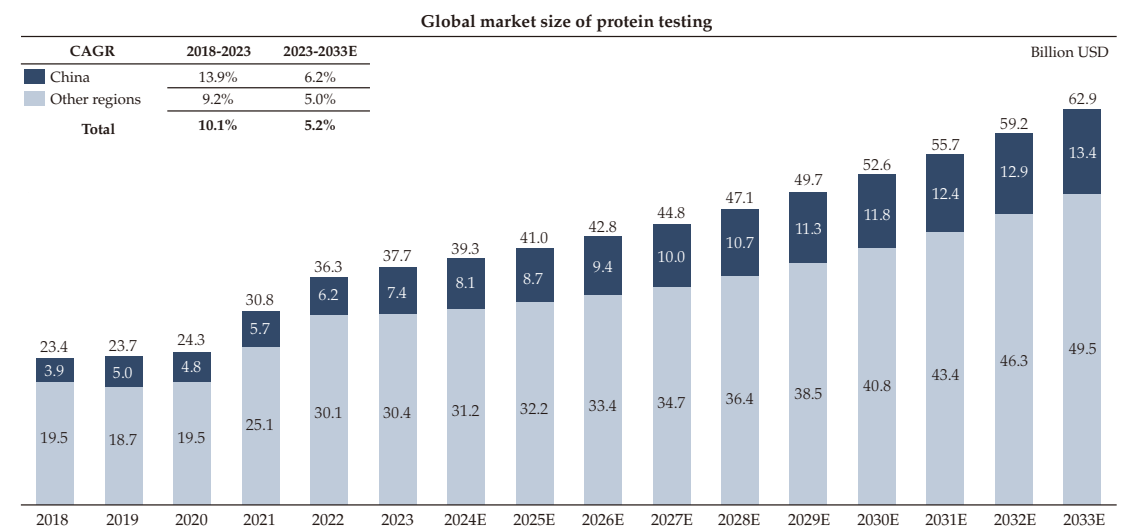
Key protein sequencing methods include Edman degradation sequencing, mass spectrometry-based sequencing, next-generation protein sequencing, and electrochemical long-read next-generation protein sequencing. The following table provides an overview of the principles of these methods.

Classification	Edman Degradation Sequencing	Mass Spectrometry-based Sequencing	Next-generation Protein Sequencing	Electrochemistry long-reading Next-generation protein sequencing
Working principles	The Edman degradation method sequentially identifies amino acids from a protein's N-terminus. It uses phenylisothiocyanate (PITC) to form a phenylthiocarbamoyl derivative, which is then cleaved to release the N-terminal amino acid as a phenylthiohydantoin for identification. This cycle repeats to determine the protein sequence	Mass Spectrometry-based Sequencing ionizes molecules, generating charged ions. These ions are separated by their mass-to-charge ratio in an electric or magnetic field. The resulting mass spectrum is analyzed to determine the molecular weight and structure of the analytes, enabling sequence determination	Capture the fluorescent signal from each N-terminal amino acid (NAA) binding event. Aminopeptidases cleave each N-terminal amino acid, exposing the next N terminal amino acid for recognition. The process repeats until the entire peptide is sequenced	Electrochemistry long-reading Next-generation protein sequencing involves threading modified single molecule protein strands into a nanopore and using electrophoresis to control their movement. The ionic current changes as each amino acid passes through the pore are detected and analyzed to determine the protein sequence
Applications	Protein structure and function studies, biopharmaceutical development, and protein engineering and mutation analysis	Used for identifying proteins, sequencing novel ones, discovering biomarkers, and diagnosing diseases like dementia, diabetes, multiple myeloma, and celiac disease	Used for high-throughput sequencing single-cell proteomics, dynamic proteomics, and disease diagnosis, but its application is still low due to challenges such as sensitivity and cost	Protein sequencing high-throughput drug development Biomarkers discovery Longevity evaluation

Source: Literature review, CIC

Global and China’s Protein Testing Market

The global protein testing market grew from US\$23.4 billion in 2018 to US\$37.7 billion in 2023, reflecting a CAGR of 10.1%, which is expected to reach US\$62.9 billion in 2033, with a CAGR of 5.2%. China’s protein testing market increased from US\$3.9 billion in 2018 to US\$7.4 billion in 2023, reflecting a CAGR of 13.9%, which is expected to reach US\$13.4 billion in 2033, with a CAGR of 6.2%. The chart below illustrates the historical and forecast size of the global and China’s protein testing markets for the periods indicated.



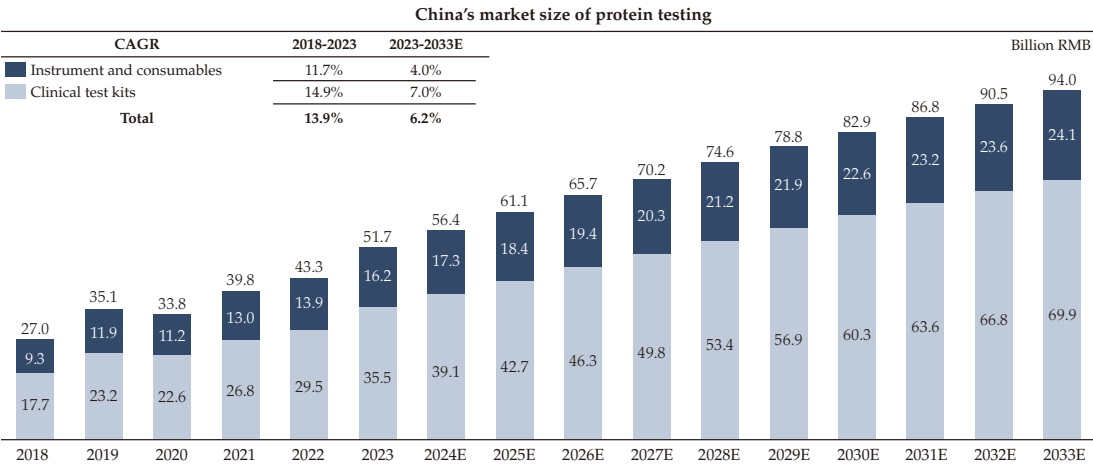
Note:

- (i) This market size includes protein testing instruments, consumables, and clinical test kits across all applications, and excludes the impact from the COVID-19 pandemic.

Source: WHO, FDA, NMPA, annual reports of listed companies, expert interviews, CIC

INDUSTRY OVERVIEW

The chart below illustrates a breakdown of the China's protein testing market by product type, including instrument and consumables and clinical test kits, for the periods indicated.



Note:

- (i) This market size includes protein testing instruments, consumables, and clinical test kits across all applications, and excludes the impact from the COVID-19 pandemic.

Source: NMPA, NHC, annual reports of listed companies, expert interviews, CIC

Growth Drivers and Future Trends of Protein Testing Market

The growth of the protein testing market is expected to be driven and shaped by the following factors:

- **Growing Prevalence of Chronic Diseases.** Chronic diseases associated with elevated C-reactive protein levels, such as rheumatoid arthritis, inflammatory bowel disease, cancer, and cardiovascular conditions, are becoming increasingly prevalent. The growing incidence is driving the use of proteomic profiling for the discovery and validation of disease-specific biomarkers, thereby fueling demand for advanced protein testing and sequencing technologies.
- **Technological Advancements.** Innovations in bioinformatics tools are significantly improving the accuracy of protein analysis. In addition, the integration of artificial intelligence and big data technologies is streamlining protein structure prediction and functional analysis, thereby shortening research and development timelines of protein testing and sequencing.
- **Multi-omics integration.** Integrating data from genomics, transcriptomics, epigenetics, and metabolomics offers a comprehensive view of disease at the molecular level. Proteomics, as a key part of multi-omics research, is becoming more important. With advancements in high-throughput technologies and large-scale clinical research, using machine learning to analyze and interpret multi-omics data is crucial for the future of precision medicine.

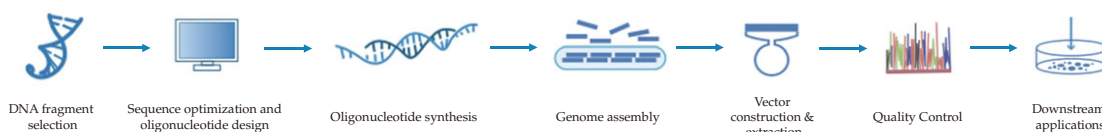
INDUSTRY OVERVIEW

- Pursue of sustainable development.** Degradation enzymes play a key role in sustainable development by offering great potential to address plastic waste. However, for enzymatic polyethylene terephthalate (PET) recycling to work effectively, the enzyme must remain stable near the glass transition temperature of PET. Therefore, environmental microbial protein sequencing is essential for identifying and optimizing novel degradation enzymes that can withstand these challenging conditions and enhance the recycling process.

OVERVIEW OF GENE SYNTHESIS MARKET

Overview of Gene Synthesis

Gene synthesis is the process of artificially creating a gene or a DNA sequence in the laboratory using chemical or enzymatic methods. This technique allows for the design and construction of custom genes with precise nucleotide sequences, enabling applications across various fields, including basic research, biotechnology, gene therapy, and synthetic biology. The following chart illustrates the process of gene synthesis.



Source: Literature review, CIC

Type of Gene Synthesis

The major types of gene synthesis include column-based synthesis, microarray-based synthesis, and enzymatic synthesis.

- Column-based synthesis is a traditional method where DNA fragments are attached to a solid support, typically a column. Reagents flow through the column, building the oligonucleotide sequence step by step on the surface of the beads. Since each column synthesizes a specific sequence, high-throughput synthesizers are needed to work with multiple columns simultaneously. This method is widely used and reliable for creating custom genes in both research and industrial applications.
- Microarray-based synthesis synthesizes multiple oligonucleotides in parallel on a microarray chip. This technique allows for high-throughput gene synthesis, generating large quantities of custom DNA sequences on a small scale. Microarray synthesis technologies, such as photolithography, electrochemical methods, and ink-jet printing, each offer unique advantages for different synthesis needs.

INDUSTRY OVERVIEW

- Enzymatic synthesis uses enzyme catalysis to synthesize DNA oligonucleotides without relying on natural templates, offering precise control over the sequence and length of the DNA. Although enzymatic synthesis has advanced in recent years, challenges such as enzyme stability and the cost of large-scale production still limit its industrial use.

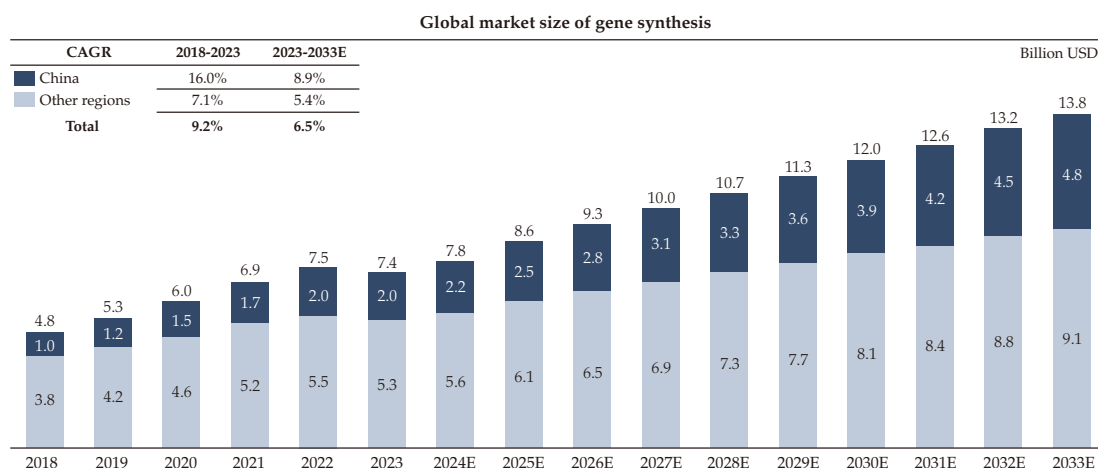
The following table illustrates a comparison of different types of gene synthesizer.

Type of synthesizer	Technical principle	Error rate	Flexibility	Scalability	Cost	Toxic chemicals	Development constraints
Column-based synthesizer	Phosphoramidite	🕒	🕒	🕒	🕒	🕒	High synthesis cost; difficult to develop synthesis instruments
Microarray-based synthesizers	Photolithography	🕒	🕒	🕒	🕒	🕒	High technology threshold; patent threshold
	Electrochemical Ink-jet printing	🕒	🕒	🕒	🕒	🕒	
Enzymatic Synthesizers	Enzyme catalysis	🕒	🕒	🕒	🕒	🕒	Low technology maturity

Source: Literature review, CIC

Global and China's Gene Synthesis Market

The global market size of gene synthesis grew from US\$4.8 billion in 2018 to US\$7.4 billion in 2023, reflecting a CAGR of 9.2%, which is expected to reach US\$13.8 billion in 2033, with a CAGR of 6.5%. The China's market size of gene synthesis increased from US\$1.0 billion in 2018 to US\$2.0 billion in 2023, reflecting a CAGR of 16.0%, which is expected to reach US\$4.8 billion in 2033, with a CAGR of 8.9%. The chart below illustrates the historical and forecast size of the global and China's gene synthesis markets for the periods indicated.



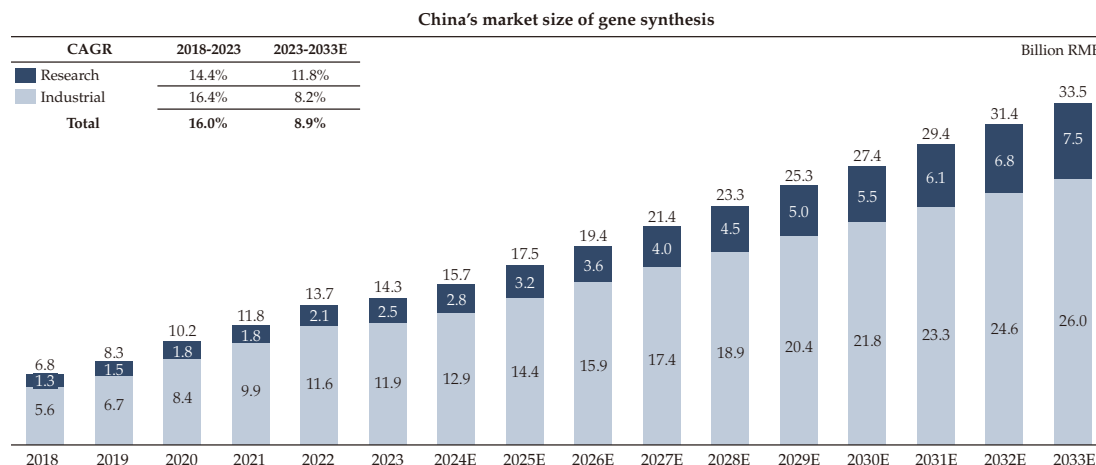
Note:

- This market size includes global oligo synthesis, gene synthesis, and gene synthesis sequencing, and excludes the impact from the COVID-19 pandemic.

Source: Annual reports of listed companies, expert interviews, CIC

INDUSTRY OVERVIEW

The chart below illustrates a breakdown of the China's gene synthesis market by application for the periods indicated.



Note:

- (i) This market size includes global oligo synthesis, gene synthesis, and gene synthesis sequencing, and excludes the impact from the COVID-19 pandemic.

Source: Annual reports of listed companies, expert interviews, CIC

Growth Drivers and Future Trends of Gene Synthesis Market

The growth of the gene synthesis market is expected to be driven and shaped by the following factors:

- **Technology innovation.** Innovations such as gene editing technologies, standardization of genetic components, microbial chassis engineering, and the development of cell factories are expanding the capabilities of gene synthesis. Furthermore, the integration of AI and machine learning is significantly reducing design time and accelerating progress in synthetic biology, enabling more precise and efficient gene synthesis methods.
- **Policy support.** As synthetic biology becomes increasingly important, China has been providing increasing support for the industry, expected to foster innovation and ensure a supportive environment for gene synthesis advancements. National-level programs, such as the "Synthetic Biology" special research initiative and key projects, along with provincial-level support for synthetic biology enterprises, are providing a strong foundation for the industry's growth.
- **Rising demand from research and industrial market.** The growing application of biotechnologies like synthetic biology, liquid biopsy, and cell immunotherapy is driving an industrial shift. As research capabilities and innovation grow, the demand for gene synthesis in research markets is expanding. Additionally, the needs of pharmaceutical companies, especially for gene therapy and vaccines, are boosting demand for gene synthesis, particularly in designing vectors and gene fragments.

INDUSTRY OVERVIEW

SOURCE OF INFORMATION

We engaged CIC, a market research consultant, to prepare the CIC Report for use in this document. The information from CIC disclosed in this document is extracted from the CIC Report and is disclosed with the consent of CIC. In preparing the CIC Report, CIC collected and reviewed publicly available data such as government-derived information, annual reports, trade and medical journals, industry reports and other available information gathered by not-for-profit organizations as well as market data collected by conducting interviews with industry key opinion leaders. The CIC Report assumes a stable regulatory environment and presumes that no major geopolitical events will significantly disrupt global supply chains during the forecast period. CIC further assumes stable economic growth in China and worldwide and presumes that no pandemic or similar public health emergency will occur during the forecast period.

CIC has exercised due care in collecting and reviewing the information so collected and independently analyzed the information, but the accuracy of the conclusions of its review largely relies on the accuracy of the information collected. We agreed to pay CIC a fee of RMB780,160 for the preparation and update of the CIC Report, which is not contingent on the [REDACTED] proceeding.