China's Core Status and Core Competitive Advantages in the Global Nucleotide Supply Chain

As a strategic leader in the global nucleotide industry, China has established an irreplaceable core position in the global supply chain by virtue of independently controllable complete industrial chain, large-scale production capacity advantages, cutting-edge technological breakthroughs and comprehensive balancing capability of compliance costs. It has formed a stable industrial pattern of **Intelligent Manufacturing in China, Empowering the World**, supplying high-quality, stable and cost-effective nucleotide raw materials for downstream sectors worldwide including food flavor enhancement, pharmaceutical R&D, feed nutrition and functional health care, and has become a trusted core strategic partner for global downstream clients.

I. Core Status in the Global Supply Chain: Absolute Dominance and Global Supply Hub

China is the world’s largest producer, exporter and core technology supplier of nucleotides, firmly holding the initiative of the global supply chain and providing solid guarantee for the stable operation of the global downstream industrial chain.

1. Production Capacity & Output: World-leading with Unshakable Advantages

By 2025, China’s total nucleotide production capacity ranks first globally with the capacity utilization rate staying above 85%. Its output accounts for more than 55% of the world’s total, leading the global market for consecutive years. The Asia-Pacific region contributes over 70% of global nucleotide production capacity, among which China takes up over 70% of the Asia-Pacific capacity, far ahead of traditional producers such as South Korea and Japan.

1.1. Capacity Expansion Trend

In the past five years, China’s nucleotide production capacity and output have maintained rapid growth with an annual compound growth rate exceeding 9%, much higher than the global average growth rate, effectively meeting the explosive demand in fields such as global nucleic acid drugs and functional foods.

1.2. Regional Layout Advantages

Production capacity is highly concentrated in three core regions: Yangtze River Delta, Pearl River Delta and Bohai Rim. Jiangsu, Shandong, Guangdong and Hubei provinces account for over 80% of China’s total capacity. Relying on well-established fermentation raw material bases (self-sufficiency rate of corn and starch exceeds 90%) and bio-

chemical supporting industrial clusters in these regions, an integrated industrial belt covering **raw material supply - production & manufacturing - global export** has been built to ensure efficient industrial chain connection and stable supply.

2. Market Scale & Export: Dual-driving Growth Dominate Global Trade

China's nucleotide market is driven by expanding domestic demand and booming overseas demand, serving as the core engine driving the growth of the global nucleotide market.

2.1. Global Market Contribution

The global nucleotide market size exceeded 18 billion US dollars in 2025. China's market share accounts for over 35% of the global total with an annual compound growth rate of 13%, far surpassing the global average and showing strong market vitality.

2.2. Downstream Demand Structure

Products are applied in full-scenario fields: pharmaceuticals account for 40% (raw materials for nucleic acid drugs, mRNA vaccines and diagnostic reagents), food additives 35% (flavor-enhancing I+G and infant formula food), feed nutrition 15% (immune enhancers), health products and other fields 10%.

2.3. Leading Export Status

China's nucleotide export volume reached 487 million US dollars in 2024, a year-on-year increase of 29.6%. Products are exported to more than 80 countries and regions worldwide, taking up over 45% of global trade volume. The export proportion of high-value-added products such as pharmaceutical-grade and modified nucleotides has risen to 35%, and its export quality and delivery capacity are highly recognized by leading global pharmaceutical enterprises.

3. Competitive Landscape: Gathering Leading Enterprises to Rank among Global Top Tiers

The global nucleotide market features an **oligopolistic concentration and leading enterprise-driven** pattern. Chinese enterprises have firmly entered the global first echelon, forming a competitive landscape of **Chinese leading enterprises plus international giants**.

3.1. Global Top 5 Enterprises

Two major international giants from Japan and South Korea jointly occupy 42% of the global market share; three leading domestic enterprises take up 28% of the global market share. The top five enterprises collectively control more than 70% of the global market share.

3.2. Leading Chinese Enterprises

A stable domestic industrial matrix has taken shape. The annual production capacity of disodium 5'-ribonucleotide (I+G) of domestic leading enterprises reaches 120,000 tons, accounting for 40% of the global total capacity and ranking first in China's export volume for many years. The market concentration ratio of the top five domestic enterprises exceeds 65%, presenting prominent leading industrial effects.

3.3. Unique Supply Capacity

China is the only country worldwide capable of supplying **full categories, complete specifications and all standard systems** of nucleotides, covering food-grade (FCC), pharmaceutical-grade (USP/EP, Chinese Pharmacopoeia 2025 Edition), feed-grade and electronic-grade standards, to meet diversified and customized demands of global clients.

II. Core Competitive Advantages: Six-dimensional Barriers to Create Value for Global Clients

Focusing on core demands of global downstream clients including stable supply, high quality, cost-effectiveness, compliance, customization and technological collaboration, China's nucleotide industry has built irreplaceable competitive barriers from six dimensions, providing long-term and stable value support for international cooperation.

1. Complete Industrial Chain Advantage: Self-sufficient Raw Materials to Ensure Cost and Supply Stability

Vertical integration of the whole industrial chain lays the core foundation of China's nucleotide industry, realizing full independent control covering upstream strains, raw materials and intermediates, midstream fermentation and synthesis, as well as downstream application. It can achieve over 30% flexible capacity expansion in peak seasons, completely avoiding supply interruption risks.

1.1. Upstream Independent Control

High-yield strains such as *Bacillus subtilis* and *Corynebacterium glutamicum* are independently selected and cultivated. The self-sufficiency rate of core raw materials including yeast RNA extract and corn starch exceeds 94%, getting rid of reliance on Japan, South Korea and the United States.

1.2. Efficient Midstream Collaboration

Full coverage of fermentation, enzymatic and chemical synthesis technologies. The localization rate of supporting enzyme preparations, purification fillers and fermentation equipment exceeds 85%, cutting collaborative costs by more than 20%.

1.3. Diversified Downstream Extension

Products are widely used in food, pharmaceutical, feed and health care industries. Production capacity can be rapidly switched to different-grade products to flexibly adapt to fluctuations in global market demand.

2. Technological Innovation Advantage: Iterative Process Breakthrough Leading High-end Production Capacity

China's nucleotide industry has achieved a leap from **following global technologies to taking partial lead**, with core process technologies reaching the world's top level and breaking overseas monopoly in high-end products.

2.1. World-leading Fermentation Technology

Independently optimized strain fermentation processes realize IMP conversion rate of 18g/L and GMP conversion rate of 15g/L. The fermentation cycle is shortened to 36 hours with efficiency increased by 40% and costs reduced by 19%.

2.2. Breakthrough in Bottleneck Synthesis Technologies

Mastered solid-phase phosphoramidite triester method and eco-friendly enzymatic synthesis technology. Leading domestic pharmaceutical and chemical enterprises are capable of producing GMP-grade oligonucleotides, realizing import substitution of high-purity (≥99.9%) products.

2.3. Leading Modified Nucleotide Technology

Mass production of key mRNA modified nucleotides including N1-methylpseudouridine and 5-methylcytidine has been realized. Their unit prices are 8-15 times that of ordinary nucleotides, supplying leading global mRNA vaccine manufacturers.

2.4. Growing R&D Investment

The average annual growth rate of industrial R&D investment reaches 14.5%, and leading enterprises allocate over 6% of their revenue to R&D, focusing on strain optimization, continuous flow production and functional derivatives. The number of patents is rapidly catching up with Japan and South Korea.

3. Quality & Compliance Advantage: International-aligned Standards with Globally Recognized Quality

China's nucleotide industry has established strict quality control systems fully in line with international standards, with its compliance certified by global authoritative institutions.

3.1. Internationalized Standard System

Chinese Pharmacopoeia 2025 Edition has improved nucleotide detection methods and purity requirements. NMPA has reached technical consensus with FDA on impurity identification and mutually recognized LC-HRMS detection methods, shortening the export registration cycle by 4 to 6 months.

3.2. Full-process Quality Control

Leading enterprises have obtained ISO22000, FSSC22000 and GMP certifications. The purity of pharmaceutical-grade products is steadily above 99.9% with total impurities ≤0.15% and metal ion residues less than 5ppb, meeting top international standards.

3.3. Eco-friendly Compliant Production

Enzymatic processes are widely promoted, consuming only 37% energy of chemical synthesis and reducing hazardous waste by 82%. Its environmental compliance costs are lower than those in Europe and America, complying with global ESG development trends.

4. Large-scale Manufacturing Advantage: Concentrated Capacity Release for Efficient and Stable Delivery

Large-scale production and industrial cluster effects have built core cost and delivery barriers for China's nucleotide industry.

4.1. World-leading Production Scale

China accounts for 60%-80% of global output of bulk products such as I+G, inosine and guanosine. Single factory capacity reaches ten-thousand-ton level, forming economies of scale and cutting unit costs by 30%-50% compared with Japan and South Korea.

4.2. Efficient Industrial Cluster Collaboration

The Yangtze River Delta gathers 62% of China's pharmaceutical-grade R&D resources and production capacity. Enterprises share technologies, complement production capacity and enjoy efficient logistics, boosting R&D efficiency by 40% and shortening delivery cycles by 30%-50% compared with overseas counterparts.

4.3. Sufficient Production Capacity Flexibility

Domestic idle production capacity is about 30%, enabling rapid response to global urgent orders with **72-hour production scheduling and 7-day delivery**, ensuring stable supply chains for global clients.

5. Cost & Price Advantage: Outstanding Cost-effectiveness with Strong Global Competitiveness

Supported by complete industrial chain layout, large-scale production and technological innovation, Chinese nucleotides possess prominent cost and price advantages, helping global clients cut costs and improve efficiency.

5.1. Comprehensive Cost Advantage

The comprehensive production cost is over 25% lower than that of European and American enterprises and over 15% lower than that of emerging producing countries, forming solid cost barriers.

5.2. Prominent Price Competitiveness

The export price of food-grade nucleotides is more than 15% lower than similar international products. Prices of pharmaceutical-grade and modified nucleotides are only 60%-70% of those in Europe and America while maintaining equivalent quality, achieving optimal global cost-effectiveness.

5.3. Reasonable Profit Margin

The gross profit margin of standard products stays at 25%-30%, while that of high-purity customized products and modified nucleotides can reach 40%-50%. It not only guarantees continuous enterprise investment, but also enables provision of technical support and after-sales services for global clients.

6. Policy & Industrial Ecosystem Advantage: Top-level Design Empowering Cluster Collaborative Development

National strategic support and mature industrial ecosystem provide solid guarantee for the sustainable development of China's nucleotide industry and stable supply to the global market.

6.1. Strong National Strategic Support

Nucleotides are included in the *14th Five-Year Plan for Bioeconomy Development* and *15th Five-Year Plan for Food Industry Development*, listed as key biomanufacturing raw materials. Financial support exceeds 2 billion US dollars, and the industry enjoys policy dividends such as high-tech enterprise tax incentives and export tax rebates.

6.2 Continuous Release of RCEP Dividends

The rule of origin sets a 40% regional value threshold. Enterprises can enjoy zero tariffs through layout optimization, cutting export costs to Japan and South Korea by 10%-15%. Exports to RCEP member states accounted for 63.2% of China's total nucleotide exports in 2024.

6.3. Gathering Industrial Talents

China has the world's largest pool of talents majoring in bioengineering and fermentation engineering, with three times the number of engineers of Japan and South Korea combined. Its R&D labor cost is only one-fifth of that in Europe and America. Leading enterprises jointly build R&D platforms with Chinese Academy of Sciences and universities to accelerate the transformation of technological achievements.

III. Global Supply Chain Value: Irreplaceable Strategic Hub

China's nucleotide industry not only dominates the global supply chain, but also plays an irreplaceable strategic role in safeguarding global industrial chain stability and promoting industrial upgrading.

1. Core Guarantee for Global Supply Security

More than 75% of global pharmaceutical-grade nucleotides and over 60% of food-grade nucleotides rely on Chinese supply. China acts as a stabilizer of the global supply chain, and no country can replace China in terms of supply scale and product quality in the short term.

2. Key Participant in Formulating International Standards

China leads the formulation of national nucleotide standard GB1903.38-20 and actively participates in the revision of international standards such as USP and EP, promoting the internationalization of Chinese standards and enhancing discourse power in the global market.

3. Driver of Global Industrial Upgrading

China's nucleotide industry is transforming from scale expansion to high-end, eco-friendly and customized development. The proportion of high-purity, modified and customized products has doubled compared with five years ago, leading the global nucleotide industry to move towards high-value-added development.

IV. Future Trends: Consolidate Leading Position and Advance High-end Globalization

In the future, China's nucleotide industry will continuously consolidate its global core status, focus on high-end breakthroughs, green transformation and global layout, and provide higher-quality products and services for global clients.

1. Further Concentrated Production Capacity

In the next five years, China's share of global nucleotide production capacity will exceed 60%, and the market concentration ratio of the top ten enterprises will reach 75%.

Leading enterprises will further expand scale and dominate the global market pattern.

2. Comprehensive Breakthrough in High-end Products

The proportion of pharmaceutical-grade, injection-grade and modified nucleotides will reach 50%, with the average export price rising by more than 25%, enabling in-depth integration into the global high-value-added supply chain.

3. In-depth Green and Low-carbon Transformation

Eco-friendly technologies including continuous flow fermentation, membrane separation and enzymatic synthesis will be widely promoted, cutting energy consumption by 30% and three-waste emissions by 40%, complying with global ESG trends and assisting global clients in green development.

4. Accelerated Global Layout

Domestic leading enterprises will build overseas factories in Southeast Asia and Europe to avoid trade barriers, establishing a dual supply system of **China plus overseas bases** to deliver more stable and efficient global supply chain services for international clients.

Conclusion

Supported by six core advantages including independently controllable complete industrial chain, technological innovation breakthroughs, internationally-aligned quality compliance, efficient large-scale manufacturing delivery, prominent cost-effectiveness and strong policy ecosystem support, China has become the absolute core and strategic pillar of the global nucleotide supply chain. For global downstream clients, cooperating with Chinese nucleotide suppliers means gaining integrated values including stable supply, high-quality products, competitive prices, professional technological collaboration and comprehensive compliance guarantee.

In the future, adhering to the development philosophy of **Quality Priority, Innovation-driven, Green Development and Global Win-win Cooperation**, China’s nucleotide industry will upgrade itself from the world’s largest producer to a global technological leader, standard setter and high-end core supplier. It will continuously consolidate its irreplaceable industrial status and make greater contributions to the development of global food health and pharmaceutical innovation industries.