

WHITE PAPER

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Unlocking the Potential of Biocatalysis

Advancing sustainable pharmaceutical processes



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Biocatalysis—the use of nature’s catalysts such as enzymes and cells to accelerate chemical reactions—has emerged as a transformative opportunity for sustainable and efficient chemical manufacturing. By integrating biocatalysis with traditional chemical catalysis, the pharmaceutical industry can achieve fewer process steps and significantly reduce environmental impact. This white paper explores the principles, advantages and applications of biocatalysis, underscoring its growing importance in modern drug development.

THE ROLE OF BIOCATALYSIS IN GREEN CHEMISTRY

Conventional chemical synthesis often relies on non-eco-friendly reagents and energy-intensive processes, leading to significant environmental challenges. In contrast, biocatalysis employs biodegradable enzymes that typically operate under mild conditions, substantially reducing energy consumption and waste. The principles of green chemistry, advanced by organizations such as the American Chemical Society’s Green Chemistry Institute, have played a key role in encouraging the adoption of biocatalytic processes. With a collective interest across various chemical industries to move toward greener processes, and increasing pressure from environmental regulatory agencies, pharmaceutical companies are progressively integrating biocatalysis into their operations.



ADVANTAGES OF BIOCATALYSIS

Sustainability

Biocatalysis aligns with environmental, social and governance (ESG) goals by replacing hazardous reagents/ catalysts with biodegradable enzymes, reducing energy requirements and minimizing waste. Enzymatic reactions often occur at ambient temperature and pressures, enhancing safety and cost-efficiency.

High Selectivity

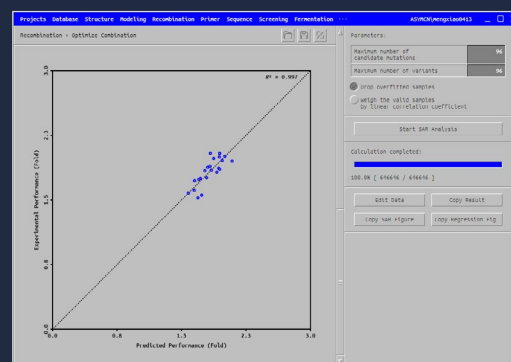
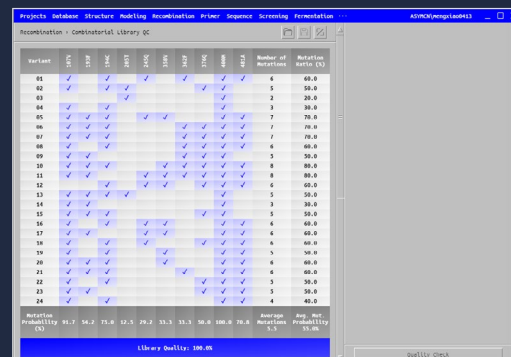
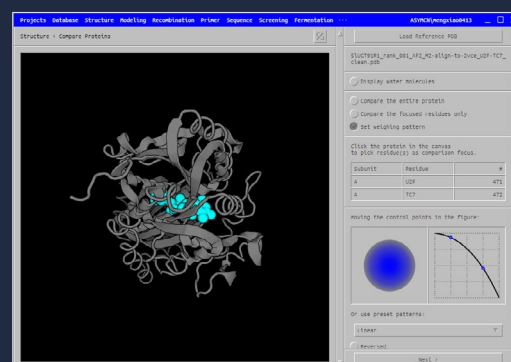
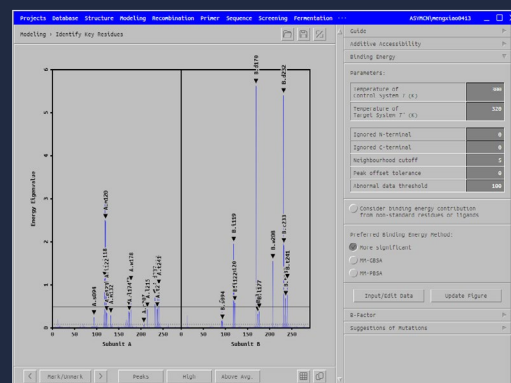
Enzymes offer exceptional precision, selectively interacting with specific substrates to minimize byproducts and maximize yields. Through enzyme engineering, they can be tailored to facilitate the synthesis of complex chiral molecules, including pharmaceutical intermediates and APIs, with very high enantiomeric purity. Recent advances in computational modeling and machine learning have revolutionized enzyme design, allowing for customized solutions tailored to industrial demands.

Operational Efficiency

Biocatalytic processes typically require fewer reaction steps, resulting in shorter timelines, lower material costs and reduced purification demands. This efficiency directly translates into cost savings and supports scalable manufacturing.

Accessibility of Engineered Enzymes

Modern advancements in enzyme engineering have expanded the range of applications for biocatalysis. Machine learning and automation accelerate enzyme discovery and optimization, enabling rapid development of customized solutions for specific chemical transformations.



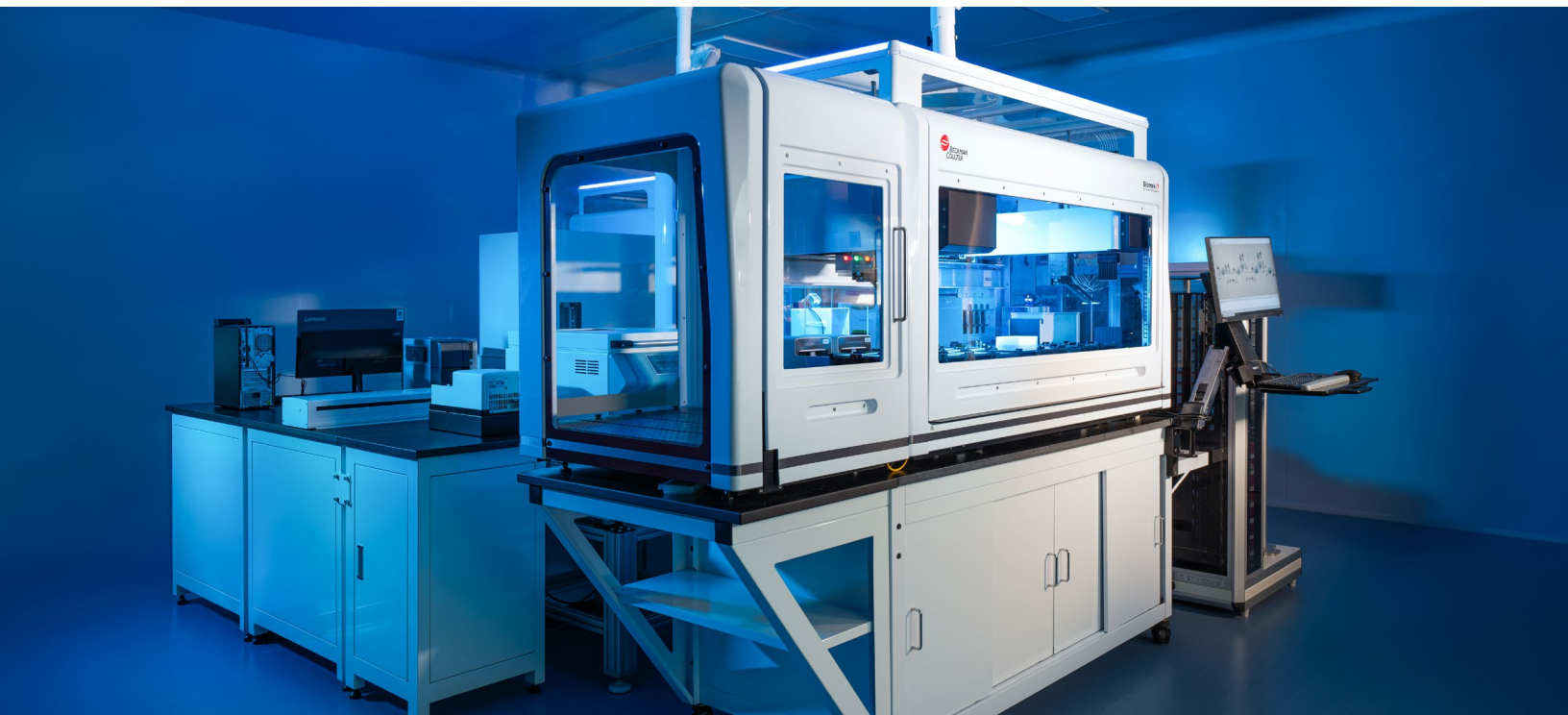
CHALLENGES IN BIOCATALYSIS

While biocatalysis offers many advantages, challenges such as sensitivity to high temperatures, extreme pH and high substrate concentrations can limit its broader application. Advances in enzyme engineering, including tailored evolution and machine learning, have addressed these issues to some extent by enhancing enzyme stability and activity under demanding conditions.

Computational tools and high-throughput screening now enable rapid optimization of enzymes for specific reactions, broadening the scope of biocatalysis. Addressing these challenges early in development and partnering with experts in enzyme engineering ensures the successful integration of biocatalysis into manufacturing processes.

BIOCATALYSIS IN PHARMACEUTICALS

Biocatalysis is poised to transform the pharmaceutical industry by enhancing sustainability, efficiency and cost-effectiveness. Early adoption of biocatalytic processes during drug development ensures optimal integration of green chemistry principles, reducing risks and maximizing benefits. As advancements in enzyme engineering continue, the accessibility and applicability of biocatalysis will expand, further solidifying its role as a cornerstone of modern pharmaceutical manufacturing.



WHY PARTNER WITH ASYMCHEM'S BIOCATALYSIS

As a global leader in the CDMO sector, Asymchem offers a robust biocatalysis platform, providing fully integrated solutions from enzyme discovery and optimization to industrial-scale application and commercialization. Our nearly decade-long expertise in enzyme engineering is complemented by cutting-edge technologies, such as AI, flow chemistry and high-throughput screening, enabling us to accelerate the development of innovative, tailored biocatalytic solutions for pharmaceutical manufacturing.

With an extensive library of over 300,000 enzymes, we support the rapid identification and optimization of enzymes for high-value compounds, including statins, antibiotics and unnatural nucleotide sugars essential for ADCs and APIs. Conducting all stages of enzyme development in-house ensures greater consistency, reduces variability and delivers higher-quality outcomes that meet the rigorous demands of pharmaceutical production.

By consolidating expertise, resources and technologies under one roof, Asymchem eliminates the challenges often associated with technology transfers. This seamless integration enhances efficiency, minimizes delays and ensures smooth project execution from start to finish.

Temperature Controlled Enzyme Storage Facility



ASYMCHEM: DRIVING PHARMA FORWARD

- **End-to-end capabilities:** Comprehensive services covering every stage, from R&D to post-commercialization.
- **Streamlined processes:** Centralized operations that improve efficiency and accelerate timelines.
- **Enhanced quality and output:** Robust enzyme engineering ensures compliance, consistency and product quality.

Asymchem's unique combination of innovation, technical expertise and commitment to excellence makes us the ideal partner for integrating biocatalysis into pharmaceutical workflows. Whether your goal is to achieve sustainability, enhance product quality or reduce costs, Asymchem is dedicated to helping you meet these objectives with confidence and success.



As a prominent leader in the CDMO sector, Asymchem (Stock Code: 002821.SZ/6821.HK) has been at the forefront of providing comprehensive R&D and integrated production solutions across the pharmaceutical value chain for over 25 years.

Building on a strong foundation in small molecule CDMO services, we have expanded our expertise to encompass peptides, oligonucleotides, biologics, drug product, and clinical research services. Our business model continues to evolve through technology transfer initiatives, with a strategic focus on continuous flow production and synthetic biology.

With state-of-the-art R&D and manufacturing facilities strategically located in key regions such as China, the United States, and the United Kingdom, our global footprint reflects our commitment to excellence. With a dedicated workforce of over 9,000 professionals— 45% of whom are exclusively focused on R&D — we proudly partner with leading pharmaceutical and biotech companies worldwide. Operating in full compliance with rigorous cGMP and EHS regulations, we address client needs by offering high-quality and cost-effective solutions that expedite clinical trial timelines and deliver customized strategies to meet the diverse requirements of the global landscape of drug development.

