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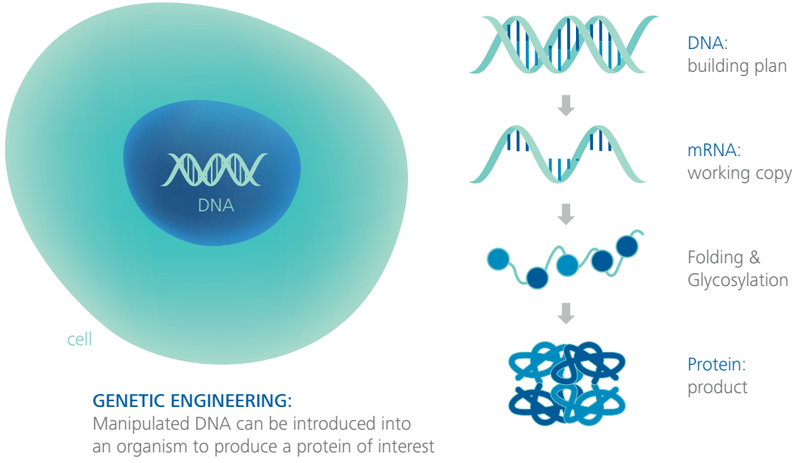
ESSENTIAL GUIDE TO PROTEIN SYNTHESIS IN BIOREACTORS

Mastering Protein Synthesis Advances Biotechnology

Protein synthesis is an example of the advancements made in biotechnological applications. This process harnesses life's intricate mechanisms to manufacture complex and specific substances. Understanding and manipulating protein synthesis principles, scientists have engineered cells to produce desired proteins, developed novel biomaterials and biocatalysts, and created targeted drug therapies. Advances in protein synthesis have also enabled the production of valuable compounds through metabolic engineering and opened up possibilities for gene therapy and protein engineering.

Proteins serve as multifunctional biomolecules, essential for catalytic reactions, structural integrity, defensive mechanisms, and regulatory processes within the cell. The protein production process involves transcribing DNA codes to RNA, which are then translated into proteins. These proteins are folded into functional shapes and often further modified through glycosylation.

The quality and yield of protein synthesis depend on the orchestration of numerous parameters, including gene expression systems, host cell lines, nutrient composition, environmental conditions, and precise control of operational factors. Advances in understanding and manipulating these parameters have improved protein production. Deciphering protein synthesis mechanisms has also identified drug development targets, such as antibiotics that inhibit bacterial protein synthesis or drugs that modulate protein production in human cells.



GENETIC ENGINEERING:
Manipulated DNA can be introduced into an organism to produce a protein of interest

The selection of the organism (the "**expression system**") for protein production, whether utilizing human or animal cell cultures or microorganisms like bacteria and fungi through fermentation, rests on certain critical requirements:

› **Production Costs**: If budget constraints are a concern, bacteria, plant cells, or fungi are typically more cost-effective.

› **Protein Glycosylation and Folding**: The complexity of the protein's post-translational modifications, particularly glycosylation and proper folding, is pivotal.

While bacteria can rapidly and inexpensively produce protein in high volumes, but often fail to achieve correct glycosylation or folding. This results in non-functional proteins. Bacteria can produce high volumes of protein quickly and cheaply, but often fail to achieve correct glycosylation or folding, resulting in non-functional proteins.

Proteins that require extensive post-translational modification, yeast expression systems may be preferred due to their eukaryotic characteristics. When human-like glycosylation patterns are required, insect or mammalian cells are the most common choice due to their closer biological resemblance to human cells. Bioreactors, such as those offered by IKA, afford higher control over the cellular environment than traditional methods, which is crucial during protein synthesis for achieving the desired protein functionality.

Bioreactor

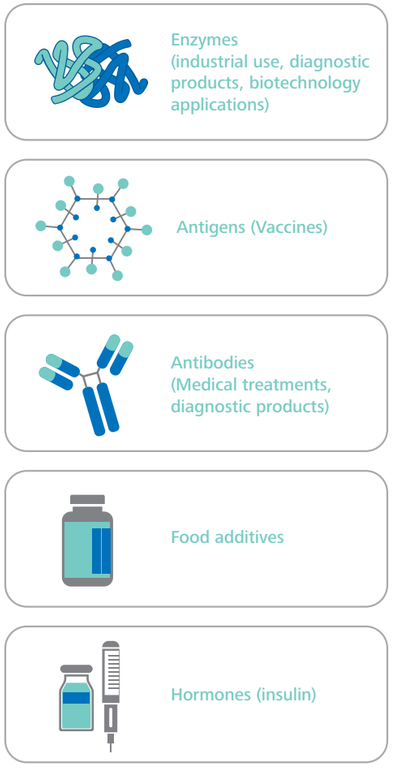


Figure Legend: Major Protein Products from Bioreactors.

What is a Bioreactor?

A bioreactor is an advanced equipment crucial for modern biotechnological innovation and integral to the field of protein synthesis. These precision devices, equipped with the latest sensors and control systems, are designed to regulate environmental parameters such as temperature, pH, and oxygen levels, creating ideal conditions for protein production in various expression systems.

Systems like the IKA HABITAT bioreactor are pivotal in transitioning protein production from small-scale laboratory settings to large-scale industrial manufacturing. They offer enhanced features that improve the quality and yield of synthesized proteins, making large-scale production feasible. Bioreactors provide precise control over the cellular environment, allowing optimization of conditions for proper protein folding and post-translational modifications.

/// Importance of a Bioreactor for Protein Synthesis

While traditional culture systems often cannot regulate variable external conditions, bioreactors are equipped with sophisticated control systems that precisely regulate all environmental parameters.

This precision creates optimal conditions for cell function and protein expression, which are often difficult to achieve with traditional techniques. As a result, bioreactors produce proteins of higher quality, with more consistency, and in greater amounts than those yielded by standard methods.

Scalability is another key advantage of using a bioreactor. Processes can be scaled from research to industrial production more effectively than with flasks or dishes that offer limited control and are prone to variability. This scalability, coupled with automation, provides consistent conditions across all production levels to maintain protein quality and yield.

Bioreactors also reduce the risk of contamination, resulting in purer protein products essential for certain applications. While traditional culturing can produce proteins adequate for research, it often lacks the consistency required for therapeutic protein manufacturing.

/// Diversity of Protein Products in Bioreactor Systems

› Enzymes(e.g. used in detergents, paper production)
› Hormones (e.g. insulin, erythropoietin & glucagon)
› Human serum albumin (HSA)
› Vaccines against hepatitis or human papillomavirus (produced in yeast)
› Protein-based drugs & monoclonal antibodies
› Proteins as a food source or meat alternative, such as single-cell proteins (SCP) produced in algae*

* Single-cell proteins (SCP) refer to edible unicellular microorganisms.

/// Why IKA HABITAT Bioreactors are Optimal to Support Protein Synthesis

Precise environmental control for cell cultivation

Mass flow controllers precisely regulate the input of air, nitrogen, and oxygen, optimizing cell growth. Dissolved oxygen (DO) levels are a critical parameter in this process.
A dedicated carbon dioxide supply system maintains optimal pH levels, while headspace gassing options facilitate efficient oxygen transfer with minimal cellular perturbation. This precise control over the cell culture environment promotes consistent and reproducible experimental results.

Advanced monitoring with next generation sensors

Advanced sensors for comprehensive bioprocess monitoring, including new-generation sensors for biomass, cell viability, and off-gas analysis, offer high selectivity, sensitivity, and long-term stability. These sensors enable contamination-free bioprocessing and improved operator efficiency by monitoring dissolved carbon dioxide, conductivity, turbidity, Redox, cell viability, off-gas, temperatures, and non-intrusive foam.
Soft-sensors can be used to calculate and display specific batch data, such as parameter setpoints, organism-specific rates (μ, qs, RQ, etc.), and extended batch values (culture broth weight, biomass).

Reducing shear stress

IKA HABITAT Bioreactors have a reactor geometry with a pitched blade and impeller design that ensures a gentle yet efficient mixing without the risk of damage from excessive shear forces. This approach optimizes the growth and maintenance of suspension and sensitive adherent cells. A new chaotic mixing mode that follows mathematical principles of chaotic-dynamic systems also provides for a more homogeneous mixture.

DESIGN AWARD 2023

/// How IKA HABITAT Bioreactors Enhance Lab Operations

IKA HABITAT Bioreactors are more than mere cultivation tools; they are integrated solutions designed to enhance operations with smoother, more efficient workflows tailored to the dynamic needs of our customers.

Award-Winning Design

Recognized with the iF DESIGN AWARD 2023, the IKA HABITAT Bioreactor integrates the capabilities of a bioreactor, photobioreactor, and fermenter, reducing the need for multiple setups and switching. Its ergonomic handling, intuitive operation, and user-friendly features, such as an open skid, unique lid stand, and lightweight components, reduce operator fatigue and improve portability. The compact design maximizes bench space. The bioreactor's intelligent support systems and controls make it accessible to both beginners and experts.

Consistent Quality

The IKA HABITAT Bioreactor sets the benchmark for consistent quality in bioprocessing by ensuring that each production cycle meets the high standards expected in the industry.
Its sophisticated control systems and precision engineering provide a dependable foundation for operations, guaranteeing uniform outputs that streamline the entire downstream process. Variable-speed, bi-directional peristaltic pumps and an optional fifth pump provide for diverse fluid management. This fidelity in performance facilitates the scalability of production and significantly reduces the occurrence of batch failures, mitigating downtime and waste.

Solutions that Scale

IKA HABITAT Bioreactors excel from micro-scale research to industrial production. They feature a chaotic mixing option for faster mixing, an advantage especially beneficial at the beginning of an experiment. The bioreactor's design includes a range of vessel volumes from 0.5L to 10L, available in both single and double-wall configurations. Properly-sized motors for each volume—small for up to 2L, and larger for 5L to 10L—ensure efficient operation and customization in contrast to the standard one-size-fits-all motor approach. Advanced, integrated control systems guarantee consistent scale-up processes, enabling seamless capacity growth.

Cross-Platform Integration

OPC UA integration and extensive interface options including USB, Ethernet, and RS-232 to provide comprehensive data connectivity. The lid's additional ports enable customized modifications to accommodate a range of bioprocessing applications.

Global Presence, Local Support

IKA's global presence provides comprehensive support, including technical service, spare parts, calibration, qualification, and commissioning, empowering customers to achieve their bioprocessing goals.

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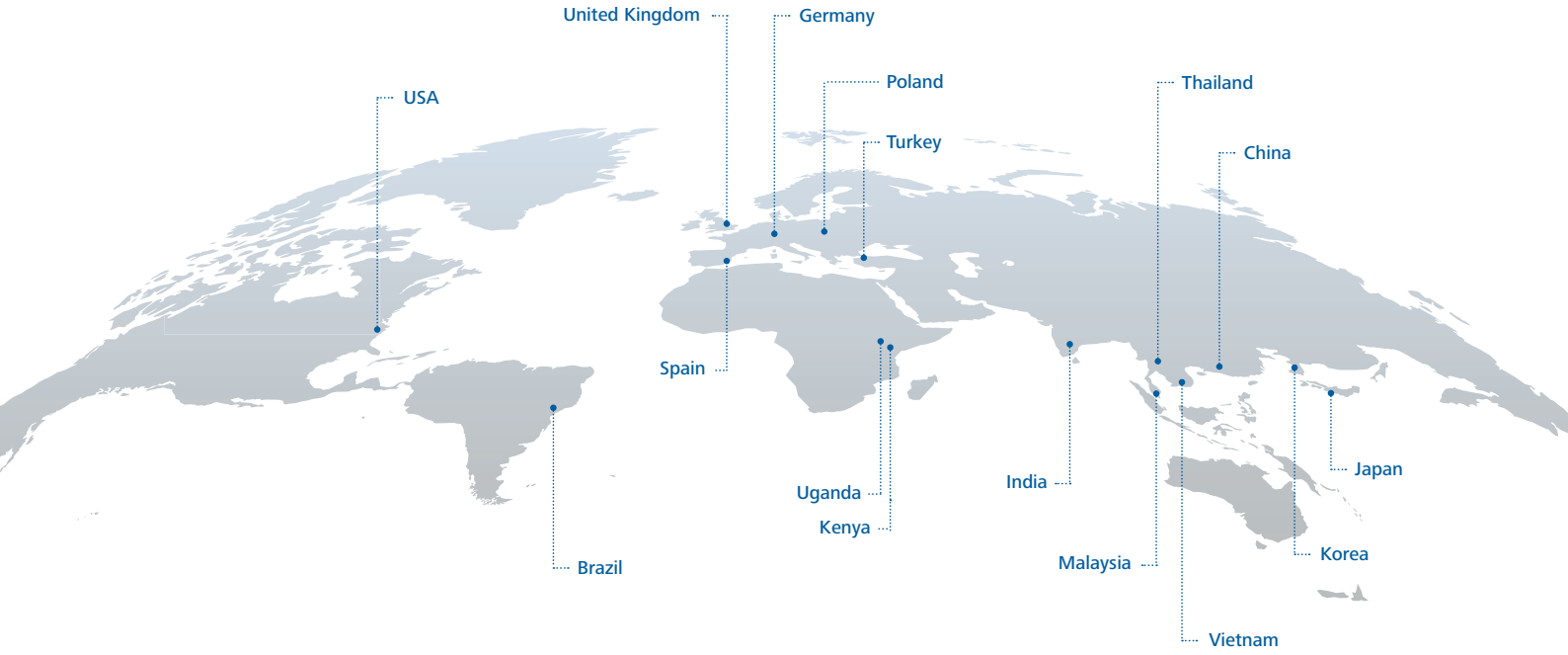

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