Advanced Microbial Fermentation for Industrial Biotechnology Training Course

Professional Development Training Course Outline

Category	Biotechnology and Pharmaceutical Development	**Duration**	10 Days
Base Fee	$4,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

The biotechnology landscape is undergoing a revolutionary shift, driven by the power of Industrial Biotechnology and Advanced Microbial Fermentation Advanced Microbial Fermentation for Industrial Biotechnology Training Course is designed to transition seasoned professionals and aspiring bioprocess engineers from foundational concepts to cutting-edge biomanufacturing expertise. The global demand for bio-based products from sustainable biopharmaceuticals and specialty chemicals to alternative proteins and biofuels is surging, making mastery of fermentation science, metabolic engineering, and bioreactor scale-up an essential, high-value skill. This program focuses on integrating modern "omics" data with Process Analytical Technology to achieve High Cell Density culture and superior Product Titer under GMP standards.

The curriculum provides a deep dive into bioprocess optimization and digital bio manufacturing, essential for minimizing production costs and reducing environmental footprint. Participants will gain practical skills in implementing Fed-Batch and Continuous Fermentation strategies, coupled with advanced control systems like PID Control and AI-driven predictive modeling. By mastering techniques like CRISPR-Cas9 for Strain Engineering and advanced Downstream Processing, attendees will be equipped to tackle complex, real-world challenges such as contamination control and rapid Scale-Up, positioning their organizations at the forefront of the Bio economy.

Programme Curriculum

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Course Objectives

1. Master the principles of Metabolic Engineering and Synthetic Biology for optimizing microbial strains for High-Value Product Titer.
2. Design and Troubleshoot Various Bioreactor Systems across different fermentation modes: Batch, Fed-Batch, and Continuous Fermentation.
3. Implement robust Scale-Up and Scale-Down methodologies using Geometric, Kinetic, and Power-Based Scaling criteria to ensure successful industrial transfer.
4. Apply principles of Process Analytical Technology and Real-Time Monitoring for dynamic Bioprocess Control and optimization.
5. Utilize CRISPR-Cas9 and other Gene-Editing Tools for targeted Strain Development and enhanced stress tolerance in industrial microbes.
6. Analyze and Interpret Multi-Omics data to characterize and improve microbial physiology and performance.
7. Develop effective Contamination Control and Aseptic Processing strategies compliant with cGMP regulations.
8. Evaluate and select sustainable Fermentation Media and utilize Novel Carbon Sources for Waste Valorisation.
9. Model and Simulate fermentation kinetics and mass transfer, using computational tools for Predictive Bioprocessing.
10. Formulate and Execute Efficient Downstream Processing strategies for product harvest, clarification, and high-purity Product Recovery.
11. Assess the Techno-Economic Feasibility and cost-benefit analysis of industrial fermentation projects, focusing on Operational Expenditure and Capital Expenditure.
12. Leverage Industry 4.0 tools like AI and Machine Learning for Process Optimization and anomaly detection in bio manufacturing.
13. Understand the regulatory pathways for biopharmaceutical and Sustainable Bio-Product commercialization.

Target Audience

1. Bioprocess Engineers and Development Scientists
2. R&D Microbiologists and Molecular Biologists
3. Production and Manufacturing Supervisors in Biotech/Pharma/Food Industries
4. Quality Assurance (QA) and Quality Control (QC) Personnel
5. Chemical Engineers transitioning into Biomanufacturing
6. Graduate Students and Post-Doctoral Researchers in Biotechnology
7. Process Equipment Vendors and Field Service Engineers
8. Project Managers overseeing fermentation-based product development

Course Modules

Module 1: Fundamentals of Advanced Microbial Physiology

- Growth rate, substrate utilization, and product formation
- Microbial central carbon metabolism and flux analysis.
- Understanding and mitigating stress responses in high-density cultures.
- Nutrient limitation and its effect on cellular states.
- Case Study: E. coli switch from growth to recombinant protein production via Plac?Çï induction.

Module 2: Strain Engineering and Synthetic Biology

- Rational strain design using Genomics and Metabolomics data.
- Advanced gene editing.
- Techniques for heterologous protein expression and secretion optimization.
- Host cell line selection: S. cerevisiae, P. pastoris, Bacillus spp.
- Case Study: Engineering yeast for sustainable, high-yield Natural Vanillin production.

Module 3: Bioreactor Design and Sterilization Principles

- Comparative analysis of stirred tank, air-lift, and Single-Use Bioreactors.
- Design considerations for mixing, gassing, and heat transfer.
- Sterilization techniques.
- Bioreactor component selection: Impellers, baffles, and sensor integration.
- Case Study: Optimizing a 2,000L stainless steel bioreactor for Monoclonal Antibody Fragment production.

Module 4: Batch and Fed-Batch Fermentation Strategies

- Defining operational parameters and characteristic phases of batch culture.
- Mathematical modeling of Fed-Batch feeding profiles.
- Strategies to overcome substrate inhibition and catabolite repression.
- High Cell Density Culture techniques for maximum volumetric productivity.
- Case Study: High-titer production of Recombinant Insulin using an optimized glucose Fed-Batch strategy.

Module 5: Continuous Fermentation and Perfusion Systems

- Principles of Chemostat and Turbidostat operation and control.
- Achieving and maintaining steady-state conditions
- Risk of strain instability and contamination in long-term continuous runs.

- Introduction to Perfusion systems and cell retention devices
- Case Study: Continuous production of Lactic Acid and impact of dilution rate on yield.

Module 6: Process Analytical Technology (PAT) and Advanced Sensors

- Implementing PAT framework for quality by design in fermentation.
- In-line and On-line monitoring
- Applications of NIR/RAMAN Spectroscopy for real-time media and product analysis.
- Integrating Soft Sensors and predictive models for unmeasurable variables.
- Case Study: Using Raman spectroscopy for real-time glucose and product concentration monitoring in Biosimilar production.

Module 7: Scale-Up and Technology Transfer

- Geometric similarity, constant power/volume, and constant KL?Çïa.
- Developing small-scale models for industrial performance prediction.
- Mixing time, shear stress, and their impact on microbial viability at large scale.
- Formal technology transfers documentation and Process Validation.
- Case Study: Scaling a lab-developed enzyme process from 5L to 10,000L production plant, focusing on maintaining KL?Çïa.

Module 8: Media Optimization and Substrate Utilization

- Designing chemically defined vs. complex media.
- Design of Experiments (DoE) and high-throughput screening.
- Using Low-Cost, sustainable substrates.
- Sterilization impact on media components
- Case Study: Utilizing a Waste-to-Value approach with glycerol feedstock for Bio-Butanol production.

Module 9: Digital Biomanufacturing and Automation

- Integration of SCADA, DCS, and PLC systems for automated control.
- Data Historians and data integrity in a regulated environment.
- Application of AI and Machine Learning for Predictive Modeling and deviation detection.
- Digital twins and process simulation for rapid scenario testing.
- Case Study: Implementing an AI-driven PID Control loop to maintain optimal dissolved oxygen set-point.

Module 10: Microbial Contamination and Aseptic Processing

- Sources and types of contamination
- Rapid detection methods.
- Implementing a robust Contamination Control Strategy (CCS).
- Validation of cleaning, sanitization (CIP/SIP), and filter integrity.
- Case Study: Root cause analysis and corrective actions (CAPA) following a Bacillus contamination event in a commercial fermentation facility.

Module 11: Principles of Downstream Processing (DSP)

- Overview of the integrated Upstream-Downstream bioprocess chain.
- Cell harvest and clarification.
- Cell disruption techniques for intracellular products
- Protein purification overview

- Case Study: Designing a DSP train for efficient recovery of a high-value Intracellular Enzyme.

Module 12: Bioprocess Economics and Techno-Economic Analysis (TEA)

- Calculating Key Performance Indicators.
- Developing OPEX (Operating Expense) and CAPEX (Capital Expense) models.
- Sensitivity analysis for feedstock cost, utility usage, and labor.
- Cost of goods sold (COGS) and strategies for process intensification.
- Case Study: Comparing the TEA of a Fed-Batch vs. a Continuous process for a commodity chemical like 1,3-Propanediol.

Module 13: Bioproduct Applications: Specialty Chemicals & Biofuels

- Fermentation for Specialty Chemicals.
- Biofuels production.
- Utilizing novel organisms for non-traditional product synthesis.
- Process constraints and market drivers for bio-based chemicals.
- Case Study: Fermentative production and purification of Succinic Acid as a platform chemical.

Module 14: Bioproduct Applications: Alternative Proteins & Food Tech

- Precision Fermentation for producing Animal-Free proteins.
- Developing microbial biomass for Single-Cell Protein (SCP) applications.
- Starter cultures and secondary metabolites for improved food functionality.
- Food safety, flavor chemistry, and sensory evaluation of fermented products.
- Case Study: Production of Animal-Free Whey Protein using engineered Pichia or Kluyveromyces.

Module 15: Regulatory Affairs and Quality in Biomanufacturing

- Overview of cGMP requirements for fermentation facilities and operations.
- Batch records, SOPs, and deviation reports.
- Risk Management using Failure Mode and Effects Analysis
- Process, cleaning, and analytical method validation.
- Case Study: FDA Inspection Readiness checklist and response to a Form 483 observation related to process control.

Training Methodology

The course employs a highly interactive and practical methodology, combining theoretical depth with hands-on application:

- Interactive Lectures.
- Process Simulation Workshops.
- Case Study Analysis.
- Virtual Bioreactor Labs.
- Group Design Projects.
- Expert Q&A Sessions.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call +254769199797

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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