Synthetic Biology for Drug and Chemical Production 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

This intensive training course is your gateway to mastering Synthetic Biology (SynBio), the revolutionary field applying engineering principles to biology for sustainable production. Synthetic biology is redefining biomanufacturing and drug discovery by enabling the rational design of microbial cell factories and biological circuits to produce high-value pharmaceuticals, bio-based chemicals, and advanced materials. As traditional chemical synthesis faces rising economic and environmental pressures, SynBio emerges as the powerful alternative for creating novel bio-based products and optimizing production pathways. This program is crucial for scientists, engineers, and industry professionals looking to harness this transformative bioengineering power.

Synthetic Biology for Drug and Chemical Production Training Course delves into cutting-edge methodologies including CRISPR-Cas9 gene editing, metabolic engineering, and computational biology. Participants will gain hands-on experience in the complete Design-Build-Test-Learn (DBTL) cycle to construct and refine biological systems, moving from concept to scalable bioproduction. A key focus will be integrating Artificial Intelligence (AI) in synthetic biology for automated design and rapid prototyping, accelerating the development of next-generation drugs and specialty chemicals. By the end of the course, you'll be equipped to lead responsible innovation in the global bioeconomy.

Programme Curriculum

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Course Objectives

1. Design and construct new biological circuits and organisms for the sustainable production of drugs and chemicals using advanced genetic engineering tools.
2. Apply CRISPR-Cas9 and other advanced genome editing tools for precise and efficient host cell engineering.
3. Implement metabolic engineering strategies for pathway balancing to maximize the yield and purity of target molecules in microbial hosts.
4. Utilize computational biology and AI/ML models to predict, design, and optimize the behavior of synthetic genetic circuits and bioproduction systems.
5. Design and implement cell-free synthesis systems for on-demand biomanufacturing of proteins, therapeutics, and small molecules.
6. Develop and evaluate scalable bioprocesses for commercial-level production of pharmaceuticals and specialty chemicals.
7. Leverage synthetic biology for genome mining and combinatorial biosynthesis in the discovery and modification of Natural Products (NPs).
8. Engineer cellular and acellular biosensors for high-throughput screening (HTS), quality control, and diagnostics.
9. Utilize omics technologies for systems biology analysis to comprehensively understand and refine engineered organisms.
10. Conduct techno-economic feasibility studies and lifecycle analyses for bio-based production processes.
11. Implement the Design-Build-Test-Learn (DBTL) cycle principles for continuous bioprocess optimization and rapid innovation.
12. Use rational design and directed evolution for protein engineering to create novel enzymes and therapeutic modalities like smart biologics.
13. Evaluate the Ethical, Legal, and Social Implications (ELSI) of synthetic biology for responsible and secure biotechnology development.

Target Audience

1. R&D Scientists/Engineers.
2. Process Development Engineers.
3. Molecular and Cellular Biologists.
4. Bioinformatics and Computational Scientists.
5. Postdoctoral Researchers and Graduate Students
6. Technology Transfer and IP Professionals.
7. Venture Capital and Investment Analysts.
8. Regulators and Policy Makers.

Course Modules

Module 1: Foundational Principles of Synthetic Biology

- The Design-Build-Test-Learn (DBTL) Cycle as an engineering paradigm for biology.
- Standardization of biological parts, BioBricks, and hierarchical abstraction.
- Case Study: The engineering of the Artemisinin precursor in yeast for antimalarial drug production.
- Introduction to key software for genetic design
- Dual-use and biosecurity considerations in SynBio research.

Module 2: DNA Synthesis and Genome Engineering

- Low-cost DNA synthesis and gene assembly methods
- Advanced use of CRISPR-Cas9 for multiplex genome editing and transcriptional control.
- Hands-on practice with guide RNA (gRNA) design and vector construction.
- Strategies for full genome redesign and minimal cell creation.
- Case Study: Engineering novel enzyme pathways using synthetic gene clusters.

Module 3: Genetic Circuit Design and Control

- Building foundational genetic circuits
- Introduction to ODE modeling of biological systems for predictive design.
- Noise mitigation, circuit robustness, and system decoupling.
- Case Study: Engineering a bacterial consortium with quorum sensing circuits for coordinated therapeutic delivery.
- Simulation and analysis of circuit behavior using computational tools.

Module 4: Advanced Metabolic Engineering for Chemicals

- Retrosynthesis and forward metabolic pathway design for non-native compounds.
- Techniques for pathway balancing, enzyme expression tuning, and precursor channeling.
- Alleviating metabolic burden and toxicity in microbial hosts.
- Case Study: Engineering E. coli or yeast for high-titer production of bio-based plastics monomers
- Enzyme screening and optimization via directed evolution.

Module 5: Microbial Cell Factories and Host Optimization

- Comparing prokaryotic and eukaryotic cell hosts.
- Rational and adaptive laboratory evolution (ALE) for strain improvement.
- High-throughput screening (HTS) and FACS sorting for engineered strains.
- Case Study: Engineering CHO cells with synthetic promoters to boost biopharmaceutical production yield.
- Channeling carbon flux and controlling cofactor availability.

Module 6: Cell-Free Systems and On-Demand Production

- Introduction to cell-free synthesis (CFS) and its advantages over in vivo systems.
- Comparing different CFS platforms
- Rapid prototyping of genetic circuits and on-demand biomanufacturing.
- Case Study: Utilizing CFS for point-of-care diagnostics and rapid vaccine production.
- Optimizing lysate preparation and reaction conditions for high-yield protein synthesis.

Module 7: Biopharmaceuticals and Novel Therapeutic Modalities

- Synthetic biology in target validation and assay development for drug discovery.
- Engineering smart biologics and next-generation therapeutic proteins
- Introduction to targeted protein degradation (PROTACs) and synthetic approaches.
- Case Study: Engineering CAR T-cells with synthetic gene circuits to enhance tumor targeting and safety switches.
- Designing allosteric biosensors for high-throughput drug screening.

Module 8: Natural Product Discovery and Biosynthesis

- Genome mining and bioinformatics for identifying novel biosynthetic gene clusters
- Combinatorial biosynthesis and pathway refactoring for NP modification.
- Case Study: Reconstituting and engineering the Taxol or Epothilone biosynthetic pathway in an easily grown host.
- Overcoming low-titer production and complex chemical structures.
- Creating new-to-nature antibiotics and high-value terpenes.

Module 9: Computational Biology and AI in SynBio

- Integrating Machine Learning for protein design and predicting pathway behavior.
- Constraint-based modeling (FBA) for metabolic network analysis.
- Automated genetic circuit design automation software
- Data management and standardization for the DBTL cycle.
- Case Study: Using deep learning for in silico screening to prioritize compound targets.

Module 10: Bioprocess Scale-Up and Engineering

- Principles of fermentation, bioreactor design, and process control.
- Overcoming scale-up bottlenecks: mass transfer, shear stress, and cell density.
- Advanced strategies for fed-batch and continuous culture.
- Case Study: Industrial scale-up of a microbe-produced commodity chemical
- Monitoring and analytics (PAT) in a biomanufacturing environment.

Module 11: Omics Technologies for Systems Analysis

- Whole-Genome Sequencing for verifying and characterizing engineered strains.
- RNA-Seq for measuring gene expression and identifying bottlenecks.
- Advanced LC-MS and GC-MS for quantifying target products and intermediates.
- Integrating multi-omics data for a holistic systems biology view.
- Case Study: Bioinformatic pipeline development for automated omics data processing.

Module 12: Biocontainment and Environmental Applications

- Strategies for biological and physical biocontainment of engineered organisms.
- Engineering biosensors for environmental pollutant detection and remediation.
- Case Study: Designing a self-powering electrochemical biosensor for environmental pollutant monitoring
- Suicide switches and other synthetic safeguards for ecological release.
- Overview of international biosafety and regulatory frameworks.

Module 13: Techno-Economic and Lifecycle Analysis

- Principles of Techno-Economic Analysis (TEA) for process valuation.
- Performing Lifecycle Analysis (LCA) to quantify environmental impact
- Evaluating feedstock costs, capital expenditure, and operating expenditure.
- Case Study: Comparing the cost and environmental profile of traditional vs. bio-based green chemical production.
- Developing a commercialization roadmap for a SynBio product.

Module 14: Responsible Innovation and IP Strategy

- Understanding the FDA, EMA, and EPA approval pathways for drugs and chemicals.
- Patent strategies for synthetic genes, circuits, and engineered organisms.
- Stakeholder analysis and public perception of advanced biotechnology.
- Promoting equitable access to SynBio-derived medicines and technologies.
- Case Study: Navigating the patent landscape for CRISPR technology and licensing models.

Module 15: Future Frontiers: XNA and Non-Standard Organisms

- Designing with Xeno-Nucleic Acids (XNA) and unnatural amino acids.
- Creating synthetic enzymes with enhanced stability and function.
- Case Study: Engineering novel scaffolds with de novo protein design for new functions.
- Advancements in cell-type agnostic engineering and synthetic tissues
- The role of SynBio in planetary health, carbon capture, and sustainable food.

Training Methodology

This course employs a participatory and hands-on approach to ensure practical learning, including:

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

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

Ready to enroll or request a customized program? Book online or contact us:

Register Online Now