Advanced Microfluidics for Biological Assays 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

Microfluidics, the science of controlling and manipulating fluids at the microscale, is rapidly transforming biological assays and diagnostics. Advanced Microfluidics for Biological Assays Training Course is designed to equip professionals with the theoretical foundations and practical expertise to design, fabricate, and implement cutting-edge Lab-on-a-Chip (LOC) devices. The shift from traditional bench-top assays to miniaturized microfluidic systems provides unparalleled advantages, including ultra-low reagent consumption, reduced analysis time, and enhanced high-throughput screening (HTS) capabilities. Mastering these techniques is critical for accelerating innovation in precision medicine, drug discovery, and point-of-care (POC) diagnostics.

This intensive course delves deep into the non-intuitive physics governing fluid behavior at the microscale, such as laminar flow, surface tension effects, and electrokinetics. Participants will gain hands-on experience with advanced fabrication methods like Soft Lithography and 3D Printing for creating next-generation microfluidic tools. The curriculum emphasizes the application of these devices across key biological frontiers, including Single-Cell Analysis, Organ-on-a-Chip (OOC) technology, and digital diagnostics. By blending theory, design principles, and practical case studies, this training prepares a new generation of scientists and engineers to leverage microfluidics for solving complex biomedical challenges, paving the way for truly automated bioassays and the future of personalized healthcare.

Programme Curriculum

Advanced Microfluidics for Biological Assays Training Course

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Course Duration

10 days

Course Objectives

1. Master the principles of Microscale Fluid Dynamics and Scaling Laws for optimal device design.
2. Design and simulate complex microfluidic architectures using Computational Fluid Dynamics (CFD) tools.
3. Implement advanced fabrication techniques, including Soft Lithography and High-Resolution 3D Printing.
4. Develop robust protocols for Droplet Microfluidics for ultra-high-throughput experimentation.
5. Apply microfluidic systems for quantitative Single-Cell Analysis and manipulation.
6. Engineer and utilize Organ-on-a-Chip (OOC) models for advanced drug toxicity and disease modeling.
7. Integrate sensing and actuation components for fully Automated Lab-on-a-Chip (LOC) platforms.
8. Evaluate and optimize microfluidic devices for Point-of-Care (POC) Diagnostics applications.
9. Utilize Inertial Microfluidics and Dielectrophoresis (DEP) for cell sorting and separation.
10. Troubleshoot common microfluidic issues, including surface fouling and microchannel clogging.
11. Design microreactors for continuous-flow Biochemical Synthesis and assay optimization.
12. Explore the integration of AI/Machine Learning with microfluidic data analysis for Digital Bioassays.
13. Create a development pathway from prototype to commercial-scale Microfluidic Biosensors.

Target Audience

1. R&D Scientists in Pharma/Biotech developing new assays or screening platforms.
2. Biomedical Engineers focused on device design and microfabrication.
3. Analytical Chemists looking to miniaturize and automate analytical techniques.
4. Postdoctoral Researchers and PhD Students in Bioengineering, Chemistry, and Biology.
5. Diagnostics Product Developers designing next-generation POC devices.
6. Process Engineers seeking to scale up microfluidic device manufacturing.
7. Clinical Researchers utilizing OOC or single-cell platforms for disease modeling.
8. Lab Managers/Directors evaluating the adoption of microfluidic technology.

Course Modules

Module 1: Foundational Microscale Fluid Dynamics

- The non-intuitive physics of low Reynolds number flow.
- Navier-Stokes and pressure-driven flow.
- Detailed analysis of surface tension and wetting in microchannel.
- Mass transport phenomena
- Case Study: Optimizing micro-mixer design for rapid reagent delivery in rapid immunodiagnostics.

Module 2: Microfabrication and Prototyping

- Mastering standard photolithography and mask design for microchannels.
- Hands-on training in PDMS Soft Lithography and bonding techniques.
- Introduction to high-resolution stereolithography 3D Printing for rapid prototyping.
- Glass, Silicon, and polymer selection.
- Case Study: Manufacturing a disposable microfluidic cartridge for infectious disease testing.

Module 3: Advanced Flow Control and Actuation

- Design and integration of active and passive microfluidic pumps and valves.
- Theory and application of Electroosmotic Flow (EOF) for fluid actuation.
- Cell and particle manipulation using Dielectrophoresis (DEP) and Acoustophoresis.
- Utilizing pneumatic control and on-chip bubble valves.
- Case Study: Designing an automated on-chip sample preparation system using EOF and micro-valves.

Module 4: Droplet Microfluidics for HTS

- Fundamental principles of monodisperse droplet generation
- Controlling droplet size, stability, and encapsulation efficiency.
- Applications in ultra-high-throughput screening and directed evolution.
- Sorting, merging, and splitting of droplets.
- Case Study: Developing a Digital PCR assay on-a-chip for absolute nucleic acid quantification.

Module 5: Single-Cell Analysis Platforms

- Methods for single-cell isolation and precise spatial positioning.
- Mimicking in vivo microenvironments for long-term cell culture.
- Fluidic control over drug concentration gradients and stimuli exposure.
- High-speed fluorescence-activated cell sorting (FACS) on-a-chip alternatives.
- Case Study: Analyzing drug response heterogeneity in individual cancer cells within a microfluidic array.

Module 6: Organ-on-a-Chip (OOC) Technology

- Design considerations for creating physiologically relevant tissue interfaces.
- Fluidic perfusion and mechanical stimulation for OOC systems.
- Models for Lung-on-a-Chip, Gut-on-a-Chip, and Blood-Brain Barrier.
- Integrating sensor technologies for real-time monitoring of tissue health.
- Case Study: Using a Liver-on-a-Chip to assess drug metabolism and toxicity with high predictive accuracy.

Module 7: Microfluidics for Nucleic Acid Assays

- Miniaturizing and accelerating Polymerase Chain Reaction (PCR) on-chip.

- Integrated sample preparation.
- Fundamentals of microchip capillary electrophoresis for DNA/RNA separation.
- Isothermal amplification techniques like LAMP for POC devices.
- Case Study: Developing a portable microfluidic device for rapid COVID-19 or pathogen detection.

Module 8: Microfluidic Biosensors and Detection

- Integrating optical detection methods on-chip.
- Design and application of electrochemical and impedance biosensors.
- Immunoassays with enhanced sensitivity.
- Principles of label-free detection, such as Surface Plasmon Resonance (SPR).
- Case Study: Creating a microfluidic immunosensor for highly sensitive, multiplexed detection of cancer biomarkers.

Module 9: Computational Fluid Dynamics (CFD) for Microfluidics

- Introduction to CFD software and meshing techniques.
- Setting up simulations for pressure-driven and electrokinetic flows.
- Modeling species transport, mixing efficiency, and cell capture.
- Iterative Geometric Optimization to enhance assay performance.
- Case Study: Simulating particle focusing in a serpentine microchannel using inertial microfluidics.

Module 10: Point-of-Care (POC) Diagnostics Implementation

- Key requirements for translating bench assays into portable diagnostics.
- Strategies for low-cost, high-volume microfluidic manufacturing and assembly.
- On-chip reagent storage and stabilization
- User-friendly interface design and robust cartridge sealing.
- Case Study: Designing a fully integrated "sample-in, answer-out" blood testing cartridge for rural clinics.

Module 11: Advanced Cell Manipulation and Sorting

- Inertial microfluidics principles for particle and cell focusing.
- Separation techniques using Deterministic Lateral Displacement (DLD) arrays.
- Isolation of Circulating Tumor Cells (CTCs) and other rare cells from blood.
- Active vs. passive cell separation methods comparison.
- Case Study: Developing a microfluidic chip for label-free isolation of fetal cells from maternal blood for non-invasive prenatal diagnosis.

Module 12: Microfluidics for Drug Discovery and Screening

- Miniaturized dose-response curve generation and IC50?Çï measurements.
- Creating 3D cell culture and spheroid models on-chip for better in vivo correlation.
- High-content imaging and automated data acquisition for Phenotypic Screening.
- Implementing multi-parameter Toxicity Testing assays.
- Case Study: Utilizing a microfluidic array for rapid screening of a compound library against a 3D cancer spheroid model.

Module 13: Data Analysis and Automation

- Fundamentals of image acquisition and automated processing in microfluidics.
- Integrating control software and instrumentation for system automation.

- Introduction to Machine Learning for rapid analysis of complex microfluidic data.
- Developing robust data pipelines for high-throughput experiments.
- Case Study: Using an AI-driven vision system to automatically count and classify cells in a droplet microfluidic assay.

Module 14: Surface Chemistry and Bio-Interface Engineering

- Strategies for surface functionalization and immobilization of biomolecules.
- Methods to minimize and prevent biofouling and non-specific adsorption.
- Using polymers and coatings to control protein-surface interactions.
- Fabricating responsive and cell-friendly substrates
- Case Study: Engineering a surface-modified microchannel to selectively capture a target bacterial species without cross-contamination.

Module 15: Regulatory Landscape and Commercialization

- Overview of in Vitro Diagnostics (IVD) regulations.
- Implementing Quality Management Systems (QMS) for device development.
- Strategies for scalability and transferring technology to high-volume manufacturing.
- Intellectual Property (IP) strategy for microfluidic innovations.
- Case Study: Analyzing the commercial journey of a successful microfluidic diagnostics company, from patent filing to market launch.

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

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