Advanced High-Content Imaging Analysis 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

High-Content Imaging (HCI) and High-Content Screening (HCS) have fundamentally transformed modern drug discovery and systems biology. This powerful, multidisciplinary technology marries automated microscopy with sophisticated bioimage informatics to capture and quantify vast amounts of data from biological samples. Moving far beyond traditional single-parameter assays, HCI enables the multiparametric measurement of numerous cellular characteristics or phenotypes simultaneously. This transition from subjective, qualitative observation to objective, quantitative cell biology is essential for accelerating research, elucidating complex biological mechanisms, and creating more predictive in vitro models. The challenge lies in efficiently and accurately extracting meaningful insights from the resulting big data; this requires expertise in cutting-edge computational methods.

Advanced High-Content Imaging Analysis Training Course is specifically designed to equip life science professionals with the next-generation skills required to master AI-driven image analysis and data-driven decision-making in the HCS domain. We will move beyond basic image segmentation to focus on deep learning architectures like Convolutional Neural Networks (CNNs) for complex object detection, phenotypic profiling, and Mechanism-of-Action (MoA) determination. Participants will gain practical expertise in developing robust, scalable, and reproducible workflows for challenging applications such as 3D cell models, live-cell imaging, and computational toxicology. By integrating advanced programming and machine learning with core biological knowledge, this course ensures participants are at the forefront of high-throughput imaging and analysis.

Programme Curriculum

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Course Objectives

1. Master Deep Learning (DL) architectures for complex image segmentation and feature extraction in bioimages.

2. Design and implement scalable High-Throughput image analysis pipelines using open-source platforms and Python libraries.

3. Develop robust Phenotypic Profiling assays to systematically characterize cellular responses to chemical and genetic perturbations.

4. Apply advanced Multivariate Data Analysis and dimensionality reduction for visualizing and interpreting high-dimensional HCS data.

5. Critically evaluate and optimize protocols for imaging and analyzing 3D Cell Models and complex co-culture systems.

6. Implement Computational Toxicology assays for early-stage prediction of drug-induced liver injury and other adverse effects.

7. Utilize Machine Learning classifiers for automated cell classification and quality control in large-scale screens.

8. Acquire and process data from Live-Cell Imaging experiments, including motion tracking and correcting for photobleaching/phototoxicity.

9. Integrate HCS data with other multi-omics datasets for a comprehensive systems biology understanding.

10. Establish best practices for Bioimage Informatics, data management, standardization, and cloud-based data storage.

11. Troubleshoot common image artifacts and implement sophisticated preprocessing techniques

12. Determine the Mechanism-of-Action of novel compounds by clustering them based on their morphological profiles.

13. Validate and benchmark analysis algorithms to ensure the reproducibility and statistical rigor of HCS results.

Target Audience

1. Life Science Researchers.
2. R&D Scientists in Pharmaceutical and Biotechnology Companies.
3. HCS Core Facility Managers and Staff.
4. Computational Biologists and Bioinformaticians entering the image analysis field.
5. Toxicologists and Safety Scientists focused on in vitro testing.
6. Assay Development Scientists
7. Data Scientists applying Machine Learning to large biological datasets.
8. Engineers involved in developing Automated Microscopy hardware/software.

Course Modules

Module 1: HCS Workflow & Quality Control

- Experimental Design for HCS/HCI
- Fundamentals of Image Preprocessing.
- Advanced Image Artifact detection and mitigation strategies.
- Establishing Statistical Rigor for image-based readouts.
- Case Study: Optimizing a high-reproducibility assay for nuclear translocation of a transcription factor to achieve

Module 2: Advanced Image Segmentation & Object Detection

- Review of classical methods.
- Introduction to Machine Learning (ML) for Segmentation.
- Techniques for separating closely touching cells
- Segmenting subcellular objects: Mitochondria, Golgi, and cytoskeleton structures.
- Case Study: Segmenting and counting immune cells within complex tumor spheroid images using ML-based methods.

Module 3: Bioimage Feature Extraction

- Extraction of Morphological Features.
- Cell Painting and High-Dimensional Feature Space Generation.
- Feature selection and engineering: Identifying the most informative features.
- Quantifying dynamic processes: Colocalization analysis
- Case Study: Developing a morphological profile to distinguish between apoptosis, necrosis, and healthy cells using 100+ features.

Module 4: Data Normalization and Statistical Analysis

- Plate-level data normalization strategies
- Handling technical and biological variations in High-Throughput data.
- Introduction to Non-Parametric Statistics for HCS data.
- Identifying and handling outlier wells and individual cells.
- Case Study: Normalizing a 384-well screen against vehicle and maximum effect controls to calculate hit-rate and IC50?Çï values.

Module 5: Deep Learning I: Introduction to CNNs

- Fundamentals of Convolutional Neural Networks (CNNs) for image analysis.
- Understanding core concepts.
- Training principles.
- Introduction to popular Deep Learning Frameworks
- Case Study: Building a simple CNN to classify single-cell images as 'Infected' or 'Uninfected' with a high-accuracy model.

Module 6: Deep Learning II: Advanced Architectures

- Semantic Segmentation using U-Net architecture for precise pixel-level masks.
- Instance Segmentation using architectures like Mask R-CNN for object detection and separation.
- Leveraging Transfer Learning to utilize pre-trained models for biological data.
- Dealing with sparse data and unbalanced classes in HCS.
- Case Study: Implementing a U-Net model to automatically segment the nucleus and cytoplasm in fluorescent images without manual tuning.

Module 7: Phenotypic Profiling & MoA Determination

- Principles of Morphological Profiling for compound classification.
- Calculating and interpreting Compound Similarity Metrics.
- Using profiles for Mechanism-of-Action (MoA) clustering and prediction.
- Distinguishing between on-target and off-target effects using feature signatures.
- Case Study: Clustering a set of known kinase inhibitors based on their morphological profiles to identify novel compounds with similar MoAs.

Module 8: Multivariate Data Analysis & Visualization

- Dimensionality Reduction techniques.
- Interpreting the reduced feature space and component loadings.
- Clustering Algorithms for hit-type identification.
- Interactive data exploration and visualization of high-dimensional HCS data.
- Case Study: Using t-SNE to visualize the separation of compounds based on their impact on mitochondrial, nuclear, and cytoskeletal features.

Module 9: Analysis of 3D Cell Models (Spheroids/Organoids)

- Specific challenges of 3D imaging.
- Processing and analysis of Z-Stacks and 3D reconstruction.
- Quantifying features in 3D
- Whole-Organoid Analysis vs. Single-Cell Analysis within 3D structures.
- Case Study: Analyzing drug penetration and cell viability gradients within an 8-day-old tumor spheroid model.

Module 10: Live-Cell Imaging and Tracking

- Designing robust Live-Cell Imaging experiments and minimizing phototoxicity.
- Algorithms for Single-Cell Tracking.
- Quantifying dynamic cellular processes.
- Analyzing Time-Series Data and generating temporal profiles.
- Case Study: Tracking the movement and division fate of iPSC-derived cardiomyocytes exposed to an arrhythmogenic compound.

Module 11: Computational Toxicology and Safety

- Implementing Multiparametric Cytotoxicity assays for early-stage screening.
- Specific HCS readouts for organelle toxicity
- Assays for Genotoxicity and Developmental Neurotoxicity (DNT).
- Building predictive models for DILI and human-relevant adverse outcomes.
- Case Study: Building a Machine Learning model to predict compound hepatotoxicity based on a panel of cellular stress and morphology features.

Module 12: Advanced Bioimage Informatics and Data Management

- Working with large-scale image data formats
- Strategies for scalable data storage and efficient data retrieval.
- Building version-controlled and reproducible workflows and pipelines.
- Integration with Laboratory Information Management Systems (LIMS).
- Case Study: Developing a cloud-based workflow for a 100,000-compound screen, from raw image storage to final feature database generation.

Module 13: High-Content Genomics and Multi-Omics Integration

- Integrating image-based phenotypes with Transcriptomic data.
- CRISPR/siRNA-based functional screening using image readouts.
- Identifying genetic drivers of specific cellular phenotypes.
- Statistical and ML methods for cross-modal data fusion.
- Case Study: Correlating image features from an siRNA screen with gene expression data to propose a new regulatory pathway for cell cycle progression.

Module 14: Custom Algorithm Development (Python/R)

- Introduction to core image analysis libraries
- Developing custom functions for complex morphological analysis not found in commercial software.
- Implementing batch processing and parallelization for high efficiency.
- Creating custom data visualization and reporting dashboards.
- Case Study: Programming a custom Python script to quantify neurite outgrowth complexity in a developmental neuroscience assay.

Module 15: Future Trends & Best Practices

- The role of Federated Learning and data sharing standards in HCS.
- Spatial Transcriptomics and its integration with HCI.
- Strategies for assay validation and cross-platform transferability.
- Ethical considerations and bias mitigation in AI-enabled HCS.

- Case Study: Reviewing the challenges and potential of using a pooled CRISPR screen analyzed via HCS for target validation.

Training Methodology

The course will employ a **Blended Learning Approach** with a strong emphasis on practical application:

1. Lectures & Interactive Sessions.
2. Hands-on Workshops.
3. Case Studies & Peer Discussion
4. Capstone Project

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

Start Date	End Date	Location	Price
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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