Multi Scale Models Cells Tissues and Organs — Hands-on

Learn how to construct and analyze multi scale models that connect cellular dynamics to tissue level behavior and organ scale physiology. This module covers conceptual foundations, common coupling strategies, numerical considerations and practical workflows that bridge in vitro, in vivo and in silico views.

Multi Scale Models — Cells, Tissues & Organs

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Session Index

Session 1

Fee: Rs 8800 Apply Now

Foundations of Multi Scale Modeling

Why multi scale models for biology and medicine

molecular to organ scale thinking | **top down vs bottom up views** | **example use cases**

Types of models across scales

ODE and PDE based models | **agent based and cellular automata** | **lumped vs distributed descriptions**

Concepts of scale separation and coupling

time scale separation | spatial resolution choices | information flow between levels

Session 2

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Coupling Cellular & Tissue Level Models

From single cell dynamics to tissue behavior

cell state models and fate decisions | contact, signaling and mechanics | emergent tissue patterns

Coupling strategies and numerical workflow

operator splitting ideas | co-simulation approaches | data exchange between solvers

Examples in development, cancer and regeneration

patterning and morphogenesis | tumor growth in tissue context | wound healing sketches

Session 3

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Organ Scale & Hybrid Approaches

Organ level and whole body models

lumped physiology models | compartment and flow models | linking to PK PD style models

Hybrid and surrogate modeling ideas

mechanistic plus data driven | reduced order and metamodels | tradeoffs between speed and detail

Multi scale calibration and validation challenges

data at different scales | consistency across levels

avoid overfitting at one scale

Session 4

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Mini Capstone: Multi Scale Workflow

Pick a simple multi scale question and define levels to model

Theory plus guided practical

Implement a small two scale prototype and explore scenarios

simple cell and tissue coupling | parameter or input scans | basic robustness checks

Deliverables: notebook, schematic and short summary

Python or R notebook | diagram of scales and couplings | PDF or HTML summary