Master on Integrative Synthetic Biology

Engineering Molecular and Cellular Systems
1st Edition. 2021-2023

M1. FUNDAMENTALS (25 ECTS, semester 1)

Semester 1: 10/2021-02/2022

M1A – Basic principles and research topics (15 ECTS)

10-12/2021
- Introductory sessions: **essential concepts on integrative synthetic biology**

I. ASSEMBLY - Reconstitution of life-like molecular systems: Fundamental aspects of synthetic biology: engineering for understanding biological systems. Proto-cellular systems and origins of life. The macromolecules of life and their interactions. Molecular machines driving essential cell processes: information processing (replication, transcription and translation); growth and division; mobility and transport; energy transduction.

II. SYNTHESIS - Integration of functional modules in synthetic and natural cells: Bottom-up approaches to assemble modules in cell-like compartments; mastering self-organization. Top-down approaches using engineered enzymes and microorganisms (natural cell containers with programmable functionality); engineered parts, modules, and circuits to master streamlined living cells/ organisms.

01-02/2022

III. BIO-FACTORIES - Exploitation of SynBio in biotechnology and biomedicine: Industrial biotechnology: engineering of biocatalysts for bio-transformations; bioremediation and biodegradation; directed evolution of enzymes. Metabolic engineering and synthetic microbiology. SynBio approaches to combat diseases: bacterial infections, protein-related pathologies (cancer, neurodegeneration, etc). Drug delivery systems – synthetic chemical biology.

M1B – Advanced methods (10 ECTS)

10-12/2021

TOOLS: Integrated structural biology and biophysics. Molecular cell biology technologies. Advanced imaging tools. Nucleic acid and protein engineering. Protein biotechnology. Cell-free systems for bio-molecular production and functional assays. Compartments: generation and control using microfluidics. Molecular systems chemistry and engineering; drug design.

01-02/2022

In silico iSynBio: model-based bio-circuit design, simulation, optimization and control. Computational chemical biology

M2. FRONTIERS (30 ECTS, semesters 1-4)

M2A. FRONTIERS I (15 ECTS, S1-2)
M2B. FRONTIERS II (15 ECTS, S3-4)
Advanced seminars (8-10 per academic year) and **1-day workshops** (3-4 per academic year) to complement / reinforce topics covered in FUNDAMENTALS

M3. EXTENSION (10 ECTS, semesters 2-3)

M3A. EXTENSION I (5 ECTS, S2)
M3B. EXTENSION I (5 ECTS, S3)
Seminars and **workshops** on **career development, professional and transferable skills related to SynBio:** Communication skills – scientific writing and oral presentations; poster design, etc. Software-based workshops (statistics, MATLAB, imaging analysis, etc.). Project management: Research-development-innovation (R+D+i). Entrepreneurship and academia-business relations. Leadership, negotiation and team skills. Elaboration of a business proposal for an EBT (technology-based company), including technological, market and management aspects (groups of 3-4 students). Ethics and bioethics. Social Responsibility in Research. Leadership. Dissemination of science, etc. Elaboration of a prototype blog for scientific dissemination.

M4. INTEGRATED LABS (25 ECTS, semesters 2-3)

M4A. INTEGRATED LAB I (15 ECTS, S2)
M4B. INTEGRATED LAB II (10 ECTS, S3)
Lab rotations, tutored research activities, introductory research project

M5. MASTER RESEARCH PROJECT – TFM (30 ECTS, semester 4)