



Master on Integrative Synthetic Biology

Engineering Molecular and Cellular Systems

1st Edition. 2021-2023

Semester 1 (10/2021 – 02/2022)

M1. FUNDAMENTALS (25 ECTS)

M1a. Basic principles & research topics (15 ECTS): ASSEMBLY, SYNTHESIS, BIOFACTORIES

M1b. TOOLS (10 ECTS)

FUNDAMENTALS 4 (10/01/2022 – 11/02/2022):

BIOFACTORIES + TOOLS (III)

Coordination: BIOFACTORIES - J Barriuso (CIB) & J Nogales (CNB). TOOLS (III) J Nogales (CNB); I Otero & J Buceta (I₂SysBio)

BIOFACTORIES *Synthetic biology for green solutions and global health. Industrial biotechnology: biocatalyst engineering, bioremediation, biodegradation, directed evolution of enzymes. Metabolic engineering. SynBio to combat diseases: bacterial infections, protein-related pathologies. Drug delivery systems*

ENZYMES ENGINEERING FOR BIOTRANSFORMATIONS

1. Enzyme biocatalysis for green chemistry: biotransformations mediated by microbial hydrolases (Ali Prieto CIB) M18 Enero 10:00h
2. Genome mining and rational design of new biocatalysts for lignocellulose biorefineries (FJ Ruiz- Dueñas CIB) M18 Enero 11:15h
3. Design of tailor-made biocatalysts by enzyme directed evolution (S Camarero CIB) X19 Enero 10:00h
4. The revolution of directed evolution (M Alcalde ICP) X19 Enero 11:15h

INDUSTRIAL BIOTECHNOLOGY

5. Metabolic engineering of food-producing yeasts (A Aranda I₂SysBio) M25 Enero 12:30h
6. Carbon dioxide and hydrogen as feedstock for bacteria (G Durante CIB) X26 Enero 12:30h
7. Bioproduction of metallic nanoparticles in bacteria (M Carmona CIB) J27 Enero 12:30
8. Synthetic genomes and their evolution (E García ICP) J3 Feb 12:30h

POLYMERS BIOTECHNOLOGY

9. Domesticating bacteria for tailored bioplastic production (Auxi Prieto CIB-SUSPLAST) M8 10:00h
10. Systems metabolic engineering for bacterial biodegradation/bioconversion of aromatic compounds (E Díaz CIB) M8 Feb 11:15h
11. Engineering microbial cell factories by adaptive laboratory evolution (Isabel Pardo CIB-SUSPLAST) J10 Feb 10:00h
12. Nanotechnological tools: Dendrimeric and magnetic nanoparticles (J Sanz CIB) J10 Enero 11:15h

SYNTHETIC DISTRIBUTED BIOCATALYSIS

13. Biofactories based on synthetic bacterial compartmentalization (D López CNB) M15 Feb 10:00h
14. Synthetic communities-based biofactories (J Nogales CNB) M15 Feb 11:15h
15. Microbial cell to cell communication in biotechnology (J Barriuso CIB) X16 Feb 10:00h

BIOCIRCUITS & FUNCTIONAL MOTIFS

1. Introduction parts, systems and devices (I. Otero)
2. Feedforwards (J Buceta)

BIOCIRCUITS OPTIMIZATION

3. Synthetic Biocircuit Design (I. Otero)
4. Biocircuit Optimizacion (I. Otero)
5. Biocircuit Control (I. Otero)
6. Practical session: Genetic switches (I. Otero)

CHALLENGES IN SYN BIO DESIGN

7. Modeling of intracellular processes. Resource allocation (I. Otero)
8. The role of molecular noise (J. Buceta)

MACROMOLECULAR DYNAMICS

9. Queueing: proteases and degradation as a tool in synthetic biology (Arantxa Urchuegia)
10. Multicellular dynamics and tissue biomechanics (J. Buceta)

RNA-BASED SYN BIO TOOLS

11. Examples of de novo RNA sequences with targeted function (A. Jaramillo)
12. Computational and experimental design of de novo RNA sequences with targeted function (A. Jaramillo)
13. De novo virus design. (A Jaramillo)

SYNTHETIC DISTRIBUTED BIOCATALYSIS

14. Computational Protein Design (P Carbonell)
15. Metabolic Pathway Design (P Carbonell)

10/01/2022 – 18/02/2022: FUNDAMENTALS 4 (BIOFACTORIES + in silico SynBio)	
BIOFACTORIES: Synthetic biology for green solutions and global health. Industrial biotechnology: biocatalyst engineering, bioremediation, biodegradation, directed evolution of enzymes. Metabolic engineering. SynBio to combat diseases: bacterial infections, protein-related pathologies. Drug delivery systems	
TOOLS III: In silico SynBio: model-based circuit design; simulation, optimization and control; cell modelling	
FRONTIERS:	
	Lectures / Activities
	Lectures BIOFACTORIES / Lectures TOOLS III
17/01/22	
18/01/22	L1 (10:00-11:00): Enzyme biocatalysis for green chemistry: biotransformations mediated by microbial hydrolases (A Prieto CIB) L2 (11:15-12:15): Genome mining and rational design of new biocatalysts for lignocellulose biorefineries (FJ Ruiz-Dueñas CIB) L3 (12:30-13:30):
19/01/22	L1 (10:00-11:00): Design of tailor-made biocatalysts by enzyme directed evolution (S Camarero CIB) L2 (11:15-12:15): The revolution of directed evolution (M Alcalde ICP) L3 (12:30-13:30):
20/01/22	
21/01/22	
24/01/22	SEMINAR Yuval ELANI (ICL)
25/01/22	L1 (10:00-11:00): Introduction parts, systems and devices (I. Otero, I2SysBio) L2 (11:15-12:15): Introduction to Feedforwards Loops (J Buceta, I2SysBio) L3 (12:30-13:30): Metabolic engineering of food-producing yeasts (A Aranda I2SysBio)
26/01/22	L1 (10:00-11:00): Synthetic Biocircuit Design (I. Otero) L2 (11:15-12:15): Biocircuit Optimizacion (I. Otero) L3 (12:30-13:30): Carbon dioxide and hydrogen as feedstock for bacteria (G Durante CIB)
27/01/22	L1 (10:00-11:00): Biocircuit Control (I. Otero) L2 (11:15-12:15): Practical session: Genetic switches (I. Otero) L3 (12:30-13:30): Bioproduction of metallic nanoparticles in bacteria (M Carmona CIB)
28/01/22	
31/01/22	SEMINARIO: Challenges in synbio design (III) Resource allocation (Thomas Gorochowskil)
01/02/22	L1 (10:00-11:00): Modeling of intracellular processes. Resource allocation (I. Otero) L2 (11:15-12:15): The role of molecular noise (J. Buceta) L3 (12:30-13:30):
02/02/22	L1 (10:00-11:00): Queueing: proteases and degradation as a tool in synthetic biology (A. Urchuegia, I2SysBio) L2 (11:15-12:15): Multicellular dynamics and tissue biomechanics (J. Buceta) L3 (12:30-13:30): Examples of de novo RNA sequences with targeted function (A. Jaramillo, UV)
03/02/22	L1 (10:00-11:00): Computational and experimental design of de novo RNA sequences with targeted function (A. Jaramillo) L2 (11:15-12:15): De novo virus design. (A Jaramillo) L3 (12:30-13:30): Synthetic genomes and their evolution (E García ICP)
04/02/22	

07/02/22	SEMINAR – Tobias ERB (MP)
08/02/22	L1 (10:00-11:00): Domesticating bacteria for tailored bioplastic production (Auxi Prieto CIB-SUSPLAST) L2 (11:15-12:15): Systems metabolic engineering for bacterial biodegradation/bioconversion of aromatic compounds (E Díaz CIB) L3 (12:30-13:30):
09/02/22	L1 (10:00-11:00): Computational Protein Design (P Carbonell, UV) L2 (11:15-12:15): Metabolic Pathway Design (P Carbonell) L3 (12:30-13:30):
10/02/22	L1 (10:00-11:00): Engineering microbial cell factories by adaptive laboratory evolution (Isabel Pardo CIB-SUSPLAST) L2 (11:15-12:15): Nanotechnological tools: Dendrimeric and magnetic nanoparticles (J Sanz CIB) L3 (12:30-13:30): L4 (15:00-16:00): Seminario: Synthetic gene regulatory networks to study pattern formation and evolution (Yolanda Schaerli)
11/02/22	Seminario: Synthetic gene regulatory networks to study pattern formation and evolution (Y Schaerli)
14/02/22	
15/02/22	L1 (10:00-11:00): Biofactories based on synthetic bacterial compartmentalization (D López CNB) L2 (11:15-12:15): Synthetic communities-based biofactories (J Nogales CNB) L3 (12:30-13:30):
16/02/22	L1 (10:00-11:00): Microbial cell to cell communication in biotechnology (J Barriuso CIB) L2 (11:15-12:15): L3 (12:30-13:30):
17/02/22	L1 (10:00-11:00): L2 (11:15-12:15): L3 (12:30-13:30):
18/02/22	

21-23/02/2022: EXAMS 2 (FUNDAMENTALS 4)	
Day	Lectures / Activities
21/02/22	
22/02/22	
23/02/22	
24/02/22	NON LECTIVE
25/02/22	NON LECTIVE
28/02/22: DEADLINE EVAL FUNDAMENTALS	