



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)

- 3 days of classes per week (Tues, Wed, Thu): up to 3 classes / 1 h (morning; 10:00, 11:15, 12:30) + afternoon sessions (optional)
- Mon and Fri reserved for tutorials, journal clubs, **FRONTIERS** activities of the semester

M2. FRONTIERS I (2-3 seminars & 1-2 workshops)

FUNDAMENTALS 1 (04-08/10/2021)

INTRODUCTORY SESSIONS: Essentials of SynBio and related disciplines

Coordination: MISB team

FUNDAMENTALS 2 (13/10/2021 – 15/11/2021)

Engineering molecular systems (bottom-up approaches)

ASSEMBLY & SYNTHESIS (I) + TOOLS (I)

Coordination: ASSEMBLY & SYNTHESIS (I) – R Pérez, S Martín-Santamaría & G Rivas (CIB). TOOLS (I): B Monterroso, S Zorrilla & G Rivas (CIB)

FUNDAMENTALS 3 (16/11/2021 – 10/12/2021)

Engineering cellular systems (top-down approaches)

ASSEMBLY & SYNTHESIS (II) + TOOLS (II)

Coordination: R Giraldo & J Nogales (CNB); J Buceta & J Peretó (I₂SysBio)

EXAMS 1 (12/2021)

FUNDAMENTALS 4 (10/01/2022 – 18/02/2022):

BIOFACTORIES + TOOLS (III)

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

EXAMS 2 (second half 02/2022)

Semester 2 (03/2022 – 06/2022)

M2. FRONTIERS I (5-6 seminars & 2-3 workshops) – engineering synthetic and natural systems

M3. EXTENSION I

M4 LAB ROTATIONS I

04-08/10/2021 FUNDAMENTALS 1 - Welcoming and Introductory Lectures		
Day	Lectures / Activities	Teachers
04/10	10:00 – 11:30: Welcoming (*) 12:00 – 13:00: KEYNOTE SEMINAR: Synthetic Biology from scratch in a new organism (*) <i>(*) on-line</i>	G Rivas & MISB team L Serrano (CRG)
05/10	10:00 – 12:00: Introduction to the MISB + practical aspects / questions (*)	G Rivas & MISB team
06/10	10:00 – 11:15: Bottom up and top-down Synthetic Biology approaches – introductory remarks (*) 11:30 – 12:30: Synthetic Biology –story of a yearning (*)	R Giraldo (CNB) J Peretó (I2SysBio)
07/10	10:00 – 11:00: The chemical origins of life (*) 11:30 – 12:30: Proto-cell: what is in a name? (*) 16:00: OPENING LECTURE – The origin of cellular life (**) Prof. Jack Szostak (Nobel Prize Medicine 2009)	J Peretó (I2SysBio) K Ruiz-Mirazo (Biofisika-UPV) J Szostak (U. Harvard) Chairs: J Peretó & K Ruiz-Mirazo
08/10	11:00 - 13:30: SPECIAL EVENT – 25 YEARS OF THE DISCOVERY OF THE MOLECULAR BASIS OF ALKAPTONURIA (*)	MA Peñalva (CIB) coord.

(*) <https://rediris.zoom.us/j/84611619482>

ID: 846 1161 9482

Access code: 808179

(**) Broadcast live on CSIC's YouTube channel

13/10/2021 – 15/11/2021:		
FUNDAMENTALS 2 (engineering molecular systems – bottom-up approaches) ASSEMBLY & SYNTHESIS (I) + TOOLS (I) + FRONTIERS		
Day	Lectures / Activities	Teachers
	Lectures ASSEMBLY & SYNTHESIS I (in black) Lectures TOOLS 1 (in blue)	
	L1 (10:00-11:00) L2 (11:15-12:15) L3 (12:30-13:30) L4 (afternoon sessions - OPTIONAL) MOST F2 LECTURES WILL BE AT CIB (EXCEPT THOSE AT IQFR, AS SHOWN IN THE CALENDAR) (*) Online	
11/10/21	NON LECTIVE	
12/10/21	HOLIDAY	
13/10/21	10:00 – 10:30: Introduction to FUNDAMENTALS 2 MOLECULES OF LIFE AND THEIR INTERACTIONS 10:45 – 11:45: Macromolecules and small molecules. Molecular recognition. 12:00 – 13:00: Non-covalent interactions. 15:00 – 16:00: Basis of the Chemical Biology	G Rivas (CIB) S Martín-Santamaría / R Pérez (CIB)
14/10/21	10:00 – 11:30: Nucleic acids (natural and synthetic) 12:00 – 13:30: Lipids – essential concepts & assembly (membranes) 15:00 – 16:00: Carbohydrates – molecular recognition	C González (IQFR) I López Montero (UCM) FJ Cañada (CIB)
15/10/21	10:00 – 11:30: Molecular interactions in the test tube and the living cell: implications for synthetic biology research 12:00 – 13:30: Bottom-up biology: a biophysical approach	G Rivas (CIB) I López - Montero (UCM)

Day	Lectures / Activities	Teachers
18/10/21	Session on minimal cells (*) 16:00 – 16:45: J Pelletier's talk - <i>Genetic requirements for cell division in a genomically minimal cell</i> (*) 16:45-17:30: Round-table (*)	J Pelletier (UCM) C Danelon (TU Delft) R Gil (I2SysBio-UVA)
19/10/21	ESSENTIAL CELLULAR PROCESSES 10:00-11:00: Information processing - replication 11:15-12:15: Information processing – transcription 12:30-13:30: Information processing - translation (*)	R Bermejo (CIB) CF Tornero (CIB) M Valle (BioGune)
20/10/21	10:00 – 12:00: Protein folding and assembly 12:30 – 13:30: Protein modifications	D Laurents (IQFR) D Pérez-Sala (CIB)
21/10/21	10:00 - 11:00: Organization – cytoskeleton / cell division 11:30 – 13:00: Organization – cytoskeleton / intracellular traffic 15:00 – 16:00: Organization – signaling and cell adhesion	G Rivas (CIB) MA Peñalva (CIB) D Lietha (CIB)
22/10/21	10:00 – 11:00: JOURNAL CLUB 0	

Day	Lectures / Activities	Teachers
25/10/21	INTEGRATED STRUCTURAL BIOLOGY (1) 10:00 – 11:00: Introductory remarks (*)	CF Tornero (CIB)
26/10/21	INTEGRATED STRUCTURAL BIOLOGY (2) <u>Sessions at IQFR Main Hall</u> 10:00-10.45: Fundamentals of X-ray Crystallography: from molecules to crystals and beyond” Short application notes (20 min + 10 min for discussion) 11:00-11:30: Membrane Maintenance at Contact Sites 12:00 12:30 Glyco-Synthetic Biology 12:30 13:00 Conformational Versatility in Protein Complexes (*) 14:30-16:30 Practical session: Crystallization, data collection and structure solution	JA Hermoso (IQFR) A Albert (IQFR) J Sanz (IQFR) C Vega (CIB) L Infantes et al(IQFR)
27/10/21	INTEGRATED STRUCTURAL BIOLOGY (3) <u>Morning sessions at IQFR Main Hall</u> 10:00 - 11:00: NMR – fundamentals 11:15 - 12:15: NMR - Nucleic acids 12:30 - 13:30: NMR - Proteins 15:30 - 16:30: NMR – practical session <u>Afternoon session at CIB-Margarita Salas</u>	F Blanco (CIB) C González (IQFR) J Oroz (IQFR) FJ Cañada (CIB)
28/10/21	INTEGRATED STRUCTURAL BIOLOGY (4) 10:00 - 11:00: EM – fundamentals 11:15 – 12:15: EM – reconstructing cellular machines (1) 12:30 - 13:30: EM – reconstructing cellular machines (2) (*) 15:00 - 16:30: EM – practical workshop	E Arias (CIB) CF Tornero (CIB) JM Valpuesta (CNB) F Escolar & R Núñez
29/10/21	MOLECULAR INTERACTIONS: <u>Computational approaches</u> 10:00-11:00: Fundamentals 11:15-12:15: Applications 12:30-13:30: Practical cases	S Martín-Santamaría (CIB)

Day	Lectures / Activities	Teachers
01/11/21	HOLIDAY	
02/11/21	MOLECULAR INTERACTIONS: <u>Biophysical approaches</u> 10:00-11:00: AUC, light scattering 11:15-12:15: Fluorescence spectroscopy 12:30 – 13:30: Calorimetry (ITC), circular dichroism 15:00 – 16:30: Molecular interactions - practical workshop	JR Luque (CIB) S Zorrilla (CIB) B Monterroso (CIB) JR Luque et al
03/11/21	CHEMICAL BIOLOGY 10:00 – 12:00: Chemical biology tools – chemical systems and probes 12:30 – 13:30: Protein Engineering: making α -helices (*)	R. Pérez (CIB) M. Eugenio Vázquez (CiQUS – USC)
04/11/21	IMAGING (1) 10:00-12:00: Confocal and multi-D microscopy	MA Peñalva (CIB)
05/11/21	10:00 – 12:00: JOURNAL CLUB 1	

Day	Lectures / Activities	Teachers
08/11/21		
09/11/21	HOLIDAY	
10/11/21	PROTEIN PRODUCTION SESSION (*) 10:00-10:45: Fundamentals of protein production tools (*) 11:00-11:45: Membrane protein production (*) 11:45-12:30: Antibody production in cell-free systems (*) <i>Lunch break</i> 15:00-15:45: In vitro reconstitution of cell-mimicking systems (*) 15:45-16:30: Protein structural domains: evolutionary significance and biotechnological applications (*)	C Vega & A Albert C Vega (CIB) D Lietha (CIB) FJ Fernández (Abvance) C Fernández (I2SysBio) Julio Polaina (IATA-CSIC)
11/11/21	MICROFLUIDICS in Synthetic Biology 10:00 – 11:00: Fundamentals in microfluidics design (*) 11:15 – 12:15: Microdroplets in microfluidics 12:30-13:30: Microfluidics – Practical session	J Buceta (I2SysBio) B Monterroso (CIB) B Monterroso / S Zorrilla (CIB)
12/11/21	BOTTOM-UP BIOLOGY 10:00 – 11:00: Assembling a minimal cell (C Danelon) (*) 11:00 – 11:30: Colloquium of Danelon with the students (*) 12:00 – 13:00: Synthetic cells – the novo assembly with DNA technology (K Göpfrich) (*) 13:00 – 13:30: Colloquium of Göpfrich with the students (*)	Coord.: G Rivas C Danelon (TU-Delft) K Göpfrich (MPI-Heidelberg)
15/11/21	IMAGING (2) 10:00 – 12:00: Single-molecule and super-resolution tools (*)	M Nollmann (CBS-Montpellier)

16/11/2021 – 10/12/2021		
FUNDAMENTALS 3: Engineering cellular systems (top-down approaches)		
ASSEMBLY & SYNTHESIS (II) + TOOLS (II) + FRONTIERS		
Day	Lectures / Activities	Teachers
	Lectures ASSEMBLY & SYNTHESIS II (in black) Lectures TOOLS II (in blue)	
	L1 (10:00-11:00) L2 (11:15-12:15) L3 (12:30-13:30) L4 (afternoon sessions – OPTIONAL) F3 LECTURES WILL BE AT CNB (c/Darwin, 3 - Campus UAM-CSIC Cantoblanco) (*) Online	
16/11/21 Room B Hall CNB	10:00-11:00: Therapeutic bacteria: from probiotics to synthetic biology 11:15-12:15: Bacteria and immune system interface 12:30-13:30: Synbio of bacterial membrane	LA Fernández (CNB) E Veiga (CNB) D López (CNB)
17/11/21 Room B Hall CNB	10:00-11:00: Amyloids as constructive parts in SynBio 11:15-12:15: Optogenetics 12:30-13:30: Assembling structured microbial ecosystems	R Giraldo (CNB) R Giraldo (CNB) E Martínez (CNB)
18/11/21	10:00-11:00: An introduction to Biomolecular Networks in Synbio (I): from gene-regulatory networks to metabolic pathways. Introduction to Biocircuits (*) 11:15-12:15: Revisiting basic calculus tools: Introduction to ODEs (*) 12:30-13:30: An introduction to Biomolecular Networks in Synbio (II): from the reaction graph to dynamics (*)	I Otero-Muras (I2SysBio) J Buceta (I2SysBio) J Buceta (I2SysBio)
19/11/21		

Day	Lectures / Activities	Teachers
22/11/21		
23/11/21 Room 36 3 rd Floor CNB-annex	10:00-11:00: Analysis of Nonlinear ODEs (and implications in biological function): phase space analysis and bifurcations (I) (*) 11:15-12:15: Analysis of Nonlinear ODEs (and implications in biological function): phase space analysis and bifurcations (II) (*) 12:30-13:30: Analysis of biological networks: a complex-network approach (*)	J Buceta (I2SysBio) J Buceta (I2SysBio) F. Pazos (CNB)
24/11/21 Room 36 3 rd Floor CNB-annex	10:00-11:30: Making Biological Switches (*) (with on-site connection from CNB) 12:00-13:30: Clocks and rulers in life in the context of Synthetic Biology	I Otero (I2SysBio) S Ares (CNB)
25/11/21 Room 36 3 rd Floor CNB-annex	10:00-11:00: Introduction to Metabolic Network Analysis (*) (with on-site connection from CNB) 11:15-12:15: The SEVA project as a standardization approach 12:30-13:30: High-throughput pathway assembly and optimization	P Carbonell (I2SysBio) E. Martínez (CNB) Blas Blázquez (CNB)
26/11/21 Auditorium CIB-MS	12:00 - SEMINAR - Sebastian Maerkl (EPFL). Cell-free synthetic biology: bottom-up construction of complex molecular systems	S Maerkl (EPFL)

Day	Lectures / Activities	Teachers
29/11/21		
30/11/21 Room 36 3 rd Floor CNB-annex	10:00-11:00: Large-scale and high-throughput genome editing 11:15-12:15: Sequence-based assignment of protein functional sites 12:30-13:30: Genome-scale metabolic modeling	Tomás Aparicio (CNB) F. Pazos (CNB) J Nogales (CNB)
01/12/21 Room B hall CNB	10:00-11:30: Bottom up assembly of microbial ecosystem from metagenome data 12:00-13:30: Standards in synthetic biology (*) (with on-site connection from CNB)	J Tamames (CNB) M Porcar (I2SysBio)
02/12/21	Activities to be announced (Journal Club or FRONTIERS-SEMINAR)	
03/12/21		

Day	Lectures / Activities	Teachers
06/12/21	NON LECTIVE	
07/12/21	NON LECTIVE	
08/12/21	NON LECTIVE	
09/12/21	Activities to be announced (FRONTIERS-SEMINAR or Journal Club)	
10/12/21		
	EXAM WEEK (DATE TO BE DEFINED)	
13/12/21		
14/12/21		
15/12/21		
16/12/21		
17/12/21		