[E1.24 / CW-N.13]	Advanced Bottom-up Synthetic Biology	Compulsory elective module	4 CP (total) = 120 h		2 SWS
			Contact hours 2 SWS / 30 h	Independent study 90 h	

Content

Seminar: Bottom-up synthetic biology aims to reconstruct life-like functions from non-living molecular building blocks to understand the origin of life and develop biomedical applications. In this seminar, students will explore how minimal synthetic systems—such as liposomes, giant unilamellar vesicles (GUVs), proteinosomes, and polymersomes—can be engineered to mimic cellular processes including compartmentalization, signal transduction, gene expression, and cell-to-cell communication. Topics will include the design and assembly of synthetic cells, membrane biophysics, cell-free transcription–translation systems, and molecular communication between synthetic and living cells. Students will discuss selected recent research papers and critically analyze experimental strategies for mimicking biological functions in minimal synthetic cells via a bottom-up approach. The seminar emphasizes conceptual understanding and the integration of chemistry, biochemistry and biophysics approaches to design artificial systems that emulate natural cellular behaviors.

Learning outcomes and skills

After successful completion, students:

- understand the fundamental principles and design strategies of bottom-up synthetic biology, an emerging interdisciplinary field at the interface of chemistry, biochemistry, and biophysics.
- are able to explain and critically evaluate how defined molecular components can be combined to reconstruct cell-like functions.
- can analyze and discuss recent literature in the field, including experimental methods such as lipid/protein/polymer/DNA vesicle reconstitution, microfluidic assembly, and cell-free expression systems.
- are able to relate theoretical concepts of self-organization, signaling, and energy transduction to their practical implementation in minimal synthetic cells.
- have developed communication skills to present and discuss interdisciplinary research topics within a scientific audience.
- are equipped with the conceptual framework to identify and assess potential applications of synthetic cell systems in biomedicine, materials science, and biotechnology.

Admissions requirements/Conditions for participation in the module/courses

Recommended prior knowledge

Participants should have a solid understanding of basic concepts in chemistry, biochemistry and/or biophysics particularly in areas such as molecular building blocks (DNA, RNA, proteins, and lipids), membrane structure and self-assembly, molecular interactions, and the fundamentals of transcription and translation. Familiarity with experimental methods for studying biomolecular systems—such as fluorescence or confocal microscopy, and molecular modeling—will be advantageous. An interest in interdisciplinary research at the interface of chemistry and biology, and in designing molecular systems that mimic cellular behavior from the scratch, will support active and effective participation in the seminar.

Organizational details

Module allocation (degree programme/faculty)	Master Chemistry / FB14
Module transferrable to other degree programmes	Master Biochemistry / FB14
Module offered	summer semester
Duration	1 semester
Module coordinator	Dr. Chakraborty
Course requirements for credits	
Participation record	Regular and active participation
Coursework	Presentation & discussion (40 min.)
Forms of teaching / learning	Seminar
Language teaching and instruction	English
Module assessment	**Form / duration / content, if applicable**
Final module assessment	none
Cumulative module assessment consisting of	
Composition of the module grade for cumulative module assessment	

	Mode of teaching / study	Semester hours per week	Semester CP			
			1	2	3	4
Advanced Bottom-up Synthetic Biology	S	2		4		
TOTAL		2		4		