Module	**Green Chemistry - Advanced Concepts**
Code	MSLS_V3_5
Degree Programme	Master of Science in Life Sciences (MSLS)
ECTS Credits	4
Workload	Total 120 h: Contact 60 h; Self-study 60 h
Module Coordinator	**Name** Prof. Dr. Rebecca Buller **Phone** +41 (0)58 934 5438 **Email** rebecca.buller@zhaw.ch **Address** ZHAW Zurich University of Applied Sciences Life Sciences and Facility Management Campus Reidbach PO Box CH-8820 Wädenswil
Lecturers	• Rebecca Buller • Prof. Dr. Christian Adlhart • Dr. Peter Riedlberger • Guest Speakers
Entry Requirements	• Knowledge of chemistry and chemical engineering on the level of a BSc degree in chemistry • Knowledge of content of the introductory Cluster module C4 (Green Chemistry)
Learning Outcomes and Competences	• The students are able to design sustainable variants of industrial processes and to judge their potential concerning environmental and economic aspects based on new chemical as well as (bio-)chemical engineering concepts in combination with a fundamental understanding of catalysis and biocatalysis. They know that raw material availability, inherent process security, economical and ecological aspects are important in process design.
Module Content	**Chemical Catalysis** • Green chemistry and catalysis • Physical concepts of catalysis (reaction mechanisms, catalysis and kinetics, substrate catalyst interaction) • Heterogeneous catalysis (molecular concept, types of catalysts, types of reaction, new developments) • Homogeneous catalysis (transition metal catalysts, elementary reactions, complex ligands, examples) • From homogeneous to heterogeneous catalysis (immobilization, phase separation, retention)

	• Asymmetric catalysis (chirality, enantioselectivity, mechanisms of asymmetric catalysis, examples for hydrogenation reactions)
	
	Biocatalysis
	
	• Introduction to biocatalytic concepts
	• Industrially valuable enzyme classes
	• Bioretrosynthesis
	• Computational enzyme design and enzyme evolution strategies
	• Visualization of enzyme structures via Pymol
	• Industrial examples of successful biocatalytic processes
	• Industry lecture (guest speaker)
	
	Process Intensification (PI)
	• Introduction, definitions and position of PI
	• Benefits of PI (business, process, environment)
	• Toolbox of PI (equipment and methods)
	• Fundamentals of PI:
	  ○ The four principles of PI
	  ○ The four approaches of PI (structure, energy, synergy, time) to realize these principles at different scales
	• Relevant practical examples on different scales (molecular, phase and process unit) and on different stages of maturity (embryonic, growth, mature and aging)
	• Aspects of Green Engineering and Novel Green Technologies

Teaching / Learning Methods	• Lectures • short seminars • presentations • case studies • exercises • demonstrations and self-study Pre-readings will be sent by email for preparation prior to lecture. Subsequent to the lectures, additional reading may be sent for study.
Assessment of Learning Outcome	Each of the intertwined parts will be assessed by a final written or oral examination or in form of an essay. The lecturers will communicate details during the respective parts. The final grade is the un-weighted average of the grades of the three individual marks.
Bibliography	Will be announced at the beginning of the lectures. Course material can be downloaded from the MSLS Moodle platform.
Language	Mainly German, some selected lectures will be in English
Comments	
Last Update	24.09.2021