HOCHSCHULE RHEIN-WAAL
Rhine-Waal University of Applied Sciences

Handbook of Modules for the Study Course Bioengineering, B.Sc.

May 2026

valid for all students enrolled
from WS 2026/27 onwards

The most important details

Duration:	7 semesters full-time, 9 semesters part-time
Location:	Kleve
Qualification:	Bachelor of Science, B.Sc.
Course start:	annually in the winter term
Language:	English
Internship/ study abroad:	in the 6th semester
Bachelor thesis:	in the second half of the 7th semester (full time) in the 9th semester (part time)
Calculation of workload:	1 CP equals 30 hours per semester
Examinations:	all examination types as detailed in §14, 17–20 General Examination Regulations for Bachelor Degree Programmes
Literature:	Literature mentioned in the module descriptions are first recommendations and do not replace the syllabus of the module. The module coordinators assume as a rule that the titles specified always refer to the most current version.
Attendance:	Attendance of all lab courses, seminars and exercises marked * is mandatory, attendance of all seminars and exercises is recommended.

This programme is accredited by

Curriculum Bioengineering, B.Sc.

Module Code	Modules	Module Requirements	CH	Type					Exa		ECTS points*	CH							
				L	S	E	LC	Pro	graded	attestation		WT 1	ST 2	WT 3	ST 4	WT 5	ST 6	WT 7	
BE 1 4204	Basics of Economic Sciences and Law		5	5					P		5	5							
BE 1 4205	Mathematics		6	2	1	3			P		5	6							
BE 1 4209	Fundamentals of Chemistry		4	2			2		P	T	5	4							*
BE 1 4211	Cell Biology and Microbiology		4	2			2		P	T	5	4							*
BE 1 4212	Bioengineering Physics I		5	2		2	1		P	T	5	5							*
BE 1 4213	International Project Management		5	4		1				T	5	5							
BE 2 4227	Applied Chemistry		6	5			1		P	T	5		6						*
BE 2 4230	Genetics and Molecular Biology		4	2			2		P	T	5		4						*
BE 2 4231	Biochemistry		4	2			2		P	T	5		4						*
BE 2 4232	Bioengineering Physics II		5	2		2	1		P	T	5		5						*
BE 2 4233	Applied Microbiology		4	2			2		P	T	5		4						*
BE 2 4234	Applied Mathematic		4	2		2			P		5		4						
BE 3 4245	Data Analysis and Applied Statistics		4		2			2	P		5			4					
BE 3 4251	Physical Chemistry		4	2		1	1		P	T	5			4					*
BE 3 4252	Instrumental Analytics		4	2		2			P		5			4					
BE 3 4253	Measurement and Control Engineering		4	2		1	1		P	T	5			4					*
BE 3 4254	Process Engineering		5	2		2	1		P	T	5			5					*
BE 3 4255	Current Topics in Biology		4		2			2		T	5			4					
BE 4 4274	Project		4					4		T	5				4				
BE 4 4277	Bioprocess Engineering		4	2			2		P	T	5				4				*
BE 4 4278	Enzyme Engineering		4	2	1	1			P		5				4				
BE 4 4279	Bioinformatics		4	2	2				P		5				4				
	Elective modules		28						P		35				8	12		8	
BE 5 4324	Integrated Management Systems		4	1	1	2			P		5					4			
BE 5 4326	Downstream Processing		4	2	2				P		5					4			
BE 5 4327	Industrial Biotechnology		4	2	2				P		5					4			
BE 6 4391	Internship or study abroad	min. 90 ECTS points **								T	30						X		
BE 7 4392	Academic Methods and Principles		4		2	2				T	5							4	
BE 7 4393	Bachelor Thesis	min. 180 ECTS points							P		12							X	
BE 7 4394	Colloquium	207 ECTS points							P		3							X	
	total credit hours		**141**	**51**	**15**	**21**	**18**	**8**			**210**	**29**	**27**	**25**	**24**	**24**		**12**	
												30	**30**	**30**	**30**	**30**	**30**	**30**	
											ECTS points			**150**			**60**		
															210				

	total	1.Sem	2.Sem	3.Sem	4.Sem	5.Sem	6.Sem	7.Sem
CH	141	29	27	25	24	24		12
ECTS points	210	30	30	30	30	30	30	30

Abbreviations

CH = credit hours per week
E = exercise
ECTS points = European Credit Transfer System of Credit Points
L = Lecture
LC = lab course
P = examination (graded)
Pro = project
S = seminar
ST = summer term
T = attestation (passed)
WT = winter term

* ECTS points are only credited after all module parts have been successfully completed.

** In addition to the General Examination Regulations for Bachelor 's Degree Programmes regarding the admission to the internship or study abroad the student has to show the successful completion of all modules/module examinations of the first study year of the study programme.

Module Code	Elective modules		CH	Type					Exam		ECTS points*	CH		
				L	S	E	LC	Pro	graded	attestation		ST	WT	
BE 4 4301	Technical enzymology and Biocatalysis		4		4				P		5	4		
BE 4 4302	Agricultural Biotechnology and Biofuels		4		2			2	P		5	4		
BE 4 4303	Nanobiotechnology		4		4				P		5	4		
BE 4 4304	Fluid Mechanics and Dynamical Systems		4	1	1		2		P	T	5	4		*
BE 5 4351	Metabolic Engineering		4		2			2	P		5		4	
BE 5 4352	Biological Physics		4	2			2		P	T	5		4	*
BE 5 4353	Environmental Biotechnology and Microalgae		4		2			2	P		5		4	
BE 5 4354	Pharmaceutical Biotechnology and Immunology		4	2	2				P		5		4	
BE 5 4355	Biopolymers		4	2	1		1		P	T	5		4	*
BE 7 4371	Project reg. Academic Principles and Methods in preparation of Bachelor Thesis		8					8		T	10	8		
BE 7 550	Language Course		4							T	5	4		
BE 4 WPF_1	Module from any bachelor study course of Faculty of Life Sciences at Rhine-Waal University of Applied Sciences		4						P		5	4		***
BE 5 WPF_2	Module from any bachelor study course of Faculty of Life Sciences at Rhine-Waal University of Applied Sciences		4						P		5		4	***
BE 7 WPF_3	Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences		4						P		5	4		***
BE 7 WPF_4	Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences		4						P		5	4		***
	6-7 elective modules amount to		**28**								**35**			

The faculty reserves the right to determine a minimum number of participants for offering an elective subject. Admission to mandatory modules is subject to available capacities. The possibility to obtain the required number of credit points remains unaffected.

In case of new developments in the different fields of Bioengineering the faculty reserves the right to expand the range of elective modules by further study courses

*** The actual selection from any study programme of the Rhine-Waal University has to be approved by the Examination Committee of the Faculty of Life Sciences. Module code and module description of the module chosen will be used.

Assessment Methods for Bioengineering, B.Sc.

Module Code	Modules	Exam			
		graded	attestation		
BE 1 4204	Basics of Economic Sciences and Law	written exam, 120 minutes			
BE 1 4205	Mathematics	written exam, 120 minutes			
BE 1 4209	Fundamentals of Chemistry	multiple choice exam, 120 minutes	attestation for lab course	*	
BE 1 4211	Cell Biology and Microbiology	electronic exam, 120 minutes	attestation for lab course	*	
BE 1 4212	Bioengineering Physics I	written exam, 120 minutes	attestation for lab course	*	
BE 1 4213	International Project Management		1. seminar paper 2. presentation		
BE 2 4227	Applied Chemistry	1. written exam, 60 minutes 2. multiple choice exam, 60 minutes	attestation for lab course	*	
BE 2 4230	Genetics and Molecular Biology	written exam, 120 minutes	attestation for lab course	*	
BE 2 4231	Biochemistry	written exam, 120 minutes	attestation for lab course	*	
BE 2 4232	Bioengineering Physics II	written exam, 120 minutes	attestation for lab course	*	
BE 2 4233	Applied Microbiology	electronic written exam, 120 minutes	attestation for lab course	*	
BE 2 4234	Applied Mathematic	1. written exam, 120 minutes 2. assignments			
BE 3 4245	Data Analysis and Applied Statistics	written exam, 120 minutes			
BE 3 4251	Physical Chemistry	written exam, 120 minutes	attestation for lab course	*	
BE 3 4252	Instrumental Analytics	written exam, 120 minutes			
BE 3 4253	Measurement and Control Engineering	written exam, 120 minutes	attestation for lab course	*	
BE 3 4254	Process Engineering	written exam, 120 minutes	attestation for lab course	*	
BE 3 4255	Current Topics in Biology		1. presentation of scientific project with Q&A session 2. presentation		
BE 4 4274	Project		attestation for project work, depending on project chosen		
BE 4 4277	Bioprocess Engineering	electronic written exam, 120 minutes	attestation for lab course	*	
BE 4 4278	Enzyme Engineering	written exam, 120 minutes			
BE 4 4279	Bioinformatics	1. Written exam in presence (40%) 2. Scientific report (20%) 3. Mini projects (30%) 4. Practicals checkpoints (10%)			
BE 4 4301	Technical enzymology and Biocatalysis	1. written exam, 120 minutes 2. presentation			elective
BE 4 4302	Agricultural Biotechnology and Biofuels	written exam, 120 minutes			elective
BE 4 4303	Nanobiotechnology	1. written exam, 60 minutes 2. seminar presentation and summaries during the semester			elective
BE 4 4304	Fluid Mechanics and Dynamical Systems	written exam, 120 minutes	attestation for lab course	*	elective
BE 4 WPF_1	Module from any bachelor study course of Faculty of Life Sciences at Rhine-Waal University of Applied Sciences	depends on module chosen		***	elective
BE 5 4324	Integrated Management Systems	1. assignment 2. written exam, 120 minutes			
BE 5 4326	Downstream Processing	written exam, 120 minutes			
BE 5 4327	Industrial Biotechnology	1. electronic interim assessments during semester or oral exam (please contact lectuerer in latter case) 2. project report and oral presentation			
BE 5 4351	Metabolic Engineering	1. written exam, 60 minutes 2. report (one per team)			elective
BE 5 4352	Biological Physics	1. written exam, 60 minutes 2. oral exam (presentation during seminar)	attestation for lab course	*	elective
BE 5 4353	Environmental Biotechnology and Microalgae	written exam, 120 minutes			elective
BE 5 4354	Pharmaceutical Biotechnology and Immunology	1. project presentation as video 2. oral presentation during semester 3. electronic interim assessments during semester or oral exam (please contact lecturer in the latter case)			elective
BE 5 4355	Biopolymers	multiple choice exam, 120 minutes	attestation for lab course	*	elective
BE 5 WPF_2	Module from any bachelor study course of Faculty of Life Sciences at Rhine-Waal University of Applied Sciences	depends on module chosen		***	elective

BE 6 4391	Internship or study abroad		Internship: report Study abroad: 15 ECTS from foreign university, report to supervising professor		
BE 7 4371	Project reg. Academic Principles and Methods in preparation of Bachelor Thesis		depends on project chosen		elective
BE 7 550	Language Course		see the module description provided by the International Centre		elective
BE 7 WPF_3	Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences	depends on module chosen		***	elective
BE 7 WPF_4	Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences	depends on module chosen		***	elective
BE 7 4392	Academic Methods and Principles		written exam, 180 minutes		
BE 7 4393	Bachelor Thesis	Thesis, generally comprising 40–100 pages			
BE 7 4394	Colloquium	oral examination, max. 45 minutes			

Table of Contents

BE 1 4204 Basics of Economic Sciences and Law

Study Semester: **1** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	15 h	Preparation for contact time	40 h
Seminar	45 h	Literature review	15 h
Exercise	15 h	Preparation for exams	20 h
Sum	75 h	Sum	75 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Tobias Wünscher

Lecturers

Finn Rieken; N.N.

Teaching contents

Business Administration: Fundamentals of business management; production factors; core management functions; economic principles; workflow and organizational structures; introduction to marketing (market analysis, marketing mix); basics of finance and investment; fundamentals of human resource management; overview of operations and supply chain processes; elements of strategic management; entrepreneurship and innovation. *Accounting and Controlling:* introduction to financial accounting (balance sheet, income statement, basic transactions); distinction between key accounting terms (costs, expenses, revenues, income); overview of cost concepts (fixed and variable costs, acquisition and production costs); basic principles of cost accounting and contribution margin analysis.

Basics of Law: Safety and liability law: legal basis of occupational safety; technical rules, accident prevention regulation, German civil code: outline of German civil code; structure; general principles of civil law contracts; Patents and patent law: prerequisites of patents; definition of invention; patents with respect to bioengineering; patent procedure; patent infringement; European and international patent law; Genetic engineering act (GenTG): purpose and application range; terms and definitions; liability and criminal offence.

Learning objectives

On successful completion of this module, students should

Business Administration

- be able to describe the core management functions, organisational structures, marketing basics, workflow principles, and basic market mechanisms relevant to business administration[1]
- be able to explain how markets operate under competitive and monopolistic conditions and how different functional areas of a business interact to support organisational performance[2]
- be able to apply basic financial accounting principles to record simple transactions and interpret core financial statements for decision-making[3]
- be able to analyze business problems by examining cost structures, contribution margins, market conditions and internal organisational processes[4]

Law

- be able to describe the fundamental principles of civil liability, occupational safety regulations, the structure of the German Civil Code (BGB), genetic engineering law relevant for working with genetically modified organisms (GMO) and requirements relevant to professional practice[1]
- be able to explain concepts of patent law – including invention criteria and patent procedures – and their relevance for innovation, bioengineering, and intellectual property management[2]
- be able to interpret legal texts, contracts, and regulatory provisions (e.g. safety regulations, patent law, Genetic Engineering Act) and apply them to basic professional or operational scenarios[3]
- be able to assess the legal and social implications of decisions involving e.g. occupational safety and the handling of GMOs in order to act responsibly within professional contexts[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory: None

Recommended: None

Reading list

Horváth: Controlling
Dias and Shah: Introduction to Business
Nickels, McHugh and McHugh: Understanding Business
Madura: Introduction to Business
McLaney and Atrill: Accounting: An Introduction
O' Sullivan, Sheffrin and Perez: Microeconomics – Principles, Applications, and Tools
Kotler, Armstrong, Wong and Saunders: Principles of Marketing
Fosters: German Legal System and Laws
Wendler: Key Aspects of German Business Law: A Practical Manual
Burg: A Manual for Intellectual Property Management Patent Law (Manuals in Biomedical Research)

Examination in winter term 2026/27

graded exam: written exam, 120 minutes

Teaching materials and media

Beamer; overhead projector; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 1 4205 Mathematics

Study Semester: **1** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	20 h
Seminar	15 h	Literature review	10 h
Exercise	45 h	Preparation for exams	30 h
Sum	90 h	Sum	60 h

Total workload: **150 h**

Module coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Lecturers

Dr. Peter Henselder

Teaching contents

Basics of descriptive statistics, Numbers (inequalities, complex numbers); series and sequences (Power series, Taylor series, iterative methods); real-valued functions (elementary functions, curve sketching, limiting values, l'Hopital); differential calculus, (definition of derivation, derivation rules, tangent, monotony and curvature, optimization); integral calculus (indefinite integral, calculation of area - definite Integral, main theorem of differential and integral calculus, substitution rule, integration by parts, partial fraction decomposition, improper integrals)

Learning objectives

On successful completion of this module, students should

- understand[1] and provide[3] quantitative and visual summaries on data sets
- know basic mathematical concepts and procedures, in particular differential calculus and its application[1,2,3]
- be able to develop an exact way of thinking, working and wording as well as a feeling for numbers and the well-considered use of the calculator[2,3]
- be able to find and verify independent solutions[3,4,5]
- be able to interpret mathematical formulas[4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory: None

Recommended:

Reading list

Stewart, Redlin und Watson: Algebra and Trigonometry
Stewart: Calculus – Early Transcendentals. Metric International Version
Strang: Linear Algebra and 1st Applications (see http://www.mit.edu -> OpenCourseWare)
Strang: Wissenschaftliches Rechnen (see http://www.mit.edu -> OpenCourseWare)
Kaplan: Introduction to Scientific Computation and Programming
Attaway: MATLAB – A Practical Introduction to Programming and Problem Solving
Moler: Numerical Computing with MATLAB (http://www.mathworks.de/moler/index_ncm.html)
Polya: How to solve it: A New Aspect of Mathematical Method

Examination in winter term 2026/27

graded exam: written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 1 4209 Fundamentals of Chemistry

Study Semester: **1** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Lab course	30 h	Literature review	20 h
		Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

Prof. Dr. Peter F. W. Simon

Teaching contents

Lecture:
Organization of matter; atomic models, in particular the Bohr and the quantum chemical one; periodic table of elements and quantum numbers; chemical bond with special focus on covalent and ionic one; solution chemistry including the various definitions of concentration, application of the solubility constant and chemical equilibrium; acid and base chemistry in particular the definition of the *p*H-value, strong and weak acids and bases, neutralization, as well as buffer solutions; redox reactions including the definition of oxidation und reduction and the description by redox reactions; electrochemistry, in particular usage of standard reduction potentials, the Nernst equation and application as power sources

Lab course:
discrimination between pure substances, mixtures, and compounds; pressure and temperature effects on the position of the chemical equilibrium (Le Châtelier's principle); acid base-titration as a tool in chemical analysis; Effect of acids and bases on buffer systems; analysis of anions and cations by various methods; redox reaction in aqueous media and in melt; interpretation of corrosion effects based on redox series.

Learning objectives

On successful completion of this module, students should

- know the basic concepts and terms of general chemistry[1]
- be able to sketch basic inorganic reactions[2]
- be able to clearly communicate their results in oral, written and electronic formats to both scientists and the public at large[3]
- be able to execute basic laboratory procedures in accordance with general safety measures[3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises, laboratory course

Entrance requirements

Mandatory: None

Recommended: None

Reading list

Brown, LeMay, Bursten, Murphy, Woodward, Stoltzfus and Lufaso: Chemistry: the central science
Zumdahl, Zumdahl, DeCoste and Adams: Chemistry

Examination in winter term 2026/27

graded exam: multiple choice exam, 120 minutes
certificate for lab course, based on attendance and laboratory reports

Teaching materials and media

Beamer; white/black board; on-line learning management system (Moodle); demonstration material and experiments

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			

last amended: May 2026

BE 1 4211 Cell Biology and Microbiology

Study Semester: **1** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Lab course	30 h	Literature review	20 h
		Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Mònica Palmada Fenés

Lecturers

Prof. Dr. Joachim Fensterle; Prof. Dr. Mònica Palmada Fenés

Teaching contents

Lecture:
Cell biology: anatomy of pro- and eukaryotic cells; structure and function of subcellular components and cell organelles; cell growth and division; protein synthesis and sorting; movement and motility; cells and tissues
Microbiology: introduction: Microbial evolution, microorganisms and humans, historical milestones; structure and function of prokaryotes: morphology, cell wall, structures and locomotion, physiological basics; taxonomy and phylogeny of microorganisms; growing microorganisms, killing microorganisms, detecting and analysing microorganisms; selected examples

Lab course:
Cell biology: accurate pipetting of liquids, serial dilution, sterile technique; basic techniques in mammalian cell culture; transfection of mammalian cells; microscopic examination of eukaryotic cells; fluorescent labelling of organelles
Microbiology: basic techniques in microbiology; sterile technique; Gram's staining; measuring bacterial growth phases and generation time; assessing an antibiotic's minimal inhibitory concentration (MIC); transformation of bacteria; selection and screening of transformed bacteria

Learning objectives

On successful completion of this module, students should

- know important principles of cellular processes and their related structures[1]
- understand the major principles of energy generation in biological systems[2]
- be able to classify major microbial groups and know their practical relevance[2]
- be able to challenge beneficial and adverse effects of microorganisms[3]
- be able to apply the principles of sterile working[3]
- be able to write scientific lab protocols in an adequate manner[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises; lab work

Entrance requirements

Mandatory: None

Recommended: None

Reading list

Alberts: Molecular Biology of the Cell
Brock: Biology of Microorganisms
Fensterle: Biotechnologie für Dummies

Examination in winter term 2026/27

graded exam: electronic exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 1 4212 Bioengineering Physics I

Study Semester: **1** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	40 h
Exercise	30 h	Literature review	10 h
Lab course	15 h	Preparation for exams	25 h
Sum	75 h	Sum	75 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

Prof. Dr. Björn Neu

Teaching contents

Lecture/Exercises:
This module provides an introduction to key concepts in classical mechanics. Topics include kinematics, covering motion in one and multiple dimensions, and Newton's laws of motion, which form the foundation of force and dynamics. The course explores oscillations, frictional forces, and circular motion, providing insights into various types of motion. Additionally, students will learn about work and energy, with a focus on energy conservation, as well as linear and angular momentum and their conservation principles. Mechanical waves, including the Doppler effect, are also discussed, along with gravitational forces and the fundamental laws of gravity. This module establishes a solid groundwork in mechanics, essential for further studies in physics and related subjects.

Lab course:
This lab course provides hands-on experience with core physics experiments, including kinematics, linear momentum and collisions, harmonic oscillations, resonance, and moment of inertia. Emphasis is placed on the analysis and scientific presentation of measured data, developing skills in data interpretation, error analysis, and reporting.

Learning objectives

On successful completion of this module, students should

- have achieved an understanding of the principles of mechanics and thermodynamics[1,2]
- be equipped with analytical skills for solving problems in bioengineering[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises; lab course with lab reports

Entrance requirements

Mandatory: None

Recommended: None

Reading list

Giancoli; Physics for Scientists and Engineers
Zinke-Allmang; Physics for the Life Sciences

Examination in winter term 2026/27

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 1 4213 International Project Management

Study Semester: **1** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	45 h	Preparation for contact time	35 h
Seminar	15 h	Literature review	20 h
Exercise	15 h	Preparation for exams	20 h
Sum	75 h	Sum	75 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Marcel Friedrich

Lecturers

Prof. Dr. Marcel Friedrich; N.N.; Prof. Dr. Mònica Palmada Fenés

Teaching contents

Project Management: Basics of project management; objectives; course and phases of projects; target setting and project planning; creating work breakdown structures; project control: milestones, controlling

Intercultural Competence: Introduction to the topic, content and scope of the lecture; definition and models of cultures; comprehension of cultures of countries according to Hofstede; handling and comprehension of organization structures; company cultures according to Trompenaars; comprehension of cultures of regions and countries according to Trompenaars, cultures of selected countries

Communication and Presentation: Basics of communication; presentation techniques; moderation; methods of negotiation

Learning objectives

On successful completion of this module, students should

- know basic theories and methods of project- and intercultural management[1]
- be able to adopt, present and communicate connections of project- and intercultural management[3]
- be able to discuss subjects of project management in a given cultural context based on the knowledge[2]
- be able to define and develop project phases[1, 5]
- be able to explain systematic instruments of project -planning, -development and –finalization with respect to personnel, costs, timelines and quality[2]
- be able to construct simple structural plans and monitor project progress based on standardized methods[3]
- know the basics of cultures and cultural dimensions[1]
- be able to classify differences of country- and company cultures[5]

- be able to analyse differences in country cultures[4]
- be able to prepare independently and to give professional and target group oriented presentations[1,2,3]
- be able to organize and moderate meetings as well as to organize and perform events[3]
- be able to consider the social impact of professional decisions[2,3] and thus deepen their capacity to engage in society[2,3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory: None

Recommended: None

Reading list

Kuster, Huber et al.: Handbuch Projektmanagement
Clements und Gido: Effective Project Management
Burke: Project Management
Andersen, Grude und Haug: Goal Directed Project Management
International Project Management Association (ww.ipma.ch)
Project Management Institute (ww.pmi.org): Project Management Body of Knowledge (PMBok)
GPM Deutsche Gesellschaft für Projektmanagement (ww.gpm-ipma.de)
Hofsteede and Minkow: Cultures and Organizations - Software of the Mind: Intercultural Cooperation and Its Importance for Survival
Trompenaars and Hampden-Turner: Riding the Waves of Culture: Understanding Cultural Diversity in Business
Berko, Wolvin and Wolvin: Communicating; A social, career and cultural focus

Examination in winter term 2026/27

certificate: 1. seminar paper; 2. presentation

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence		X	

last amended: May 2026

BE 2 4227 Applied Chemistry

Study Semester: **2** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	75 h	Preparation for contact time	20 h
Lab course	15 h	Literature review	10 h
		Preparation for exams	30 h
Sum	90 h	Sum	60 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

Prof. Dr. Peter F. W. Simon; Prof. Dr. Amir Fahmi

Teaching contents

Lecture, seminar and exercise:
Repetition and refinement of molecular theories, in particular the valence bond model, the molecular orbital theory as well as the valence-shell electron-repulsion model and the consequences for representation of molecules by Lewis formulae; principles of the IUPAC nomenclature; transition elements and coordination chemistry including a general perspective of the elements' properties, coordination number, geometry and isomerism in *d*-block complexes, bonding theory of *d*-block complexes; repetition and refinement of the theory of inorganic as well as organic acids, bases and ions in aqueous and non-aqueous solution, solubility and precipitation; repetition and refinement of redox-reactions of inorganic as well as organic compounds; electrophilic addition reactions, focusing on the carbocation's stability and regiochemistry; electrophilic substitution reactions on aromatic compounds; reactions of carbonyl compounds with electrophiles and nucleophiles, in particular acetal formation and reactions of carboxylic acid derivatives; nucleophilic and radical substitution reactions, especially the differentiation between the various mechanisms in the scope of a retrosynthetic approach; elimination reactions focusing on the regiochemistry

Laboratory course:
Purification of educts and products by distillation, filtration, recrystallization; basic substance identification by refractive index; basic synthesis procedures: nucleophilic and electrophilic substitution, elimination, and addition reactions

Learning objectives

On successful completion of this module, students should

- know the basic terms of organic and inorganic chemistry[1]
- know the basic chemistry of the elements and their compounds[1]
- know the most prominent functional groups in organic chemistry[1]
- know the fundamental concepts of inorganic chemistry from the point of view of structure, physicochemical properties and reactivity [1]

- be able to appreciate general trends within the various functional groups as well as the different groups in the periodic table[2]
- visualize reactivity as a collection of patterns in electron movement[1,2]
- be able to organize chemical reactions according to a mechanistic approach rather than the traditional functional group concept[2]
- be able to clearly communicate their results in oral, written and electronic formats to both scientists and the public at large[3]
- be able to plan and conduct syntheses in laboratory scale[1]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Fundamentals of Chemistry (BE 1 4209)

Reading list

Zumdahl, Zumdahl, DeCoste and Adams: Chemistry
Housecroft and Sharpe: Inorganic chemistry
Lawrance and Bernhardt: Introduction to coordination chemistry
Ogilvie, Ackroyd, Browning, Deslongchamps, Lee, Sauer and Dryden: Organic chemistry: mechanistic patterns
Bruice: Organic chemistry
Brown, Iverson, Anslyn and Foote: Organic Chemistry

Examination in summer term 2027

graded exam: 1. written exam, 60 minutes; 2. multiple choice exam, 60 minutes
certificate for lab course, based on attendance and laboratory reports

Teaching materials and media

Beamer; white/black board; on-line learning management system (Moodle); demonstration material and experiments

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 2 4230 Genetics and Molecular Biology

Study Semester: **2** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Lab course	30 h	Literature review	20 h
		Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Mònica Palmada Fenés

Lecturers

Prof. Dr. Mònica Palmada Fenés

Teaching contents

Lecture:
basics of general genetics and molecular biology: history, structure of DNA, recombination, genetic code, replication, transcription, mRNA processing, translation; gene regulation in prokaryotes and eukaryotes: promoters, transcription factors; molecular biology tools: DNA sequencing, DNA libraries, functional genomics, chip technologies, hybridization and screening techniques; optimization of gene expression in prokaryotes and eukaryotes; bioinformatics: databases (NCBI, EBI), sequence analysis (alignment, homologous comparison, gene prediction, phylogenetics); genetic engineering: plasmids, recombinant DNA, PCR, cloning, transformation, transduction, transfection, conjugation

Lab course:
introducing specific mutations into DNA by site-directed mutagenesis; isolation of plasmidic DNA and sequencing; isolation of genomic DNA, restriction fragment length polymorphism (RFLP) analysis; quantitative real-time PCR; gene subcloning

Learning objectives

On successful completion of this module, students should

- know the genetic processes within a cell (replication, transcription, translation) and the principles of gene regulation[1,2]
- have gained basic knowledge on genetic engineering, especially with respect to DNA recombination tools and DNA analysis[1,2]
- be able to perform and to assess molecular biological and genetical experiments[3,4,5]
- be aware of strategies to optimize gene expression in different host organisms[2]
- understand the impact of functional genomics on genetic engineering[2,5]
- understand and be able to use public domain databases for bioinformatical issues[3,4]
- be able to consider the social and ethical impact of professional decisions[2,3] and thus deepen their capacity to engage in society[2,3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Fundamentals of Chemistry (BE 1 4209); Cell Biology and Microbiology (BE 1 4211)

Reading list

Watson, Baker, Bell and Gann: Molecular Biology of the Gene
Clark: Molecular Biology
Klug, Cummings and Spencer: Essentials of Genetics
Sambrook: The Condensed Protocols from Molecular Cloning: A Laboratory Manual
Pevsner: Bioinformatics and Functional Genomics
Yadav: Bioinformatics: A Practical Guide for Molecular Biologist: A Text Book for Beginners

Examination in summer term 2027

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 2 4231 Biochemistry

Study Semester: **2** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Lab course	30 h	Literature review	20 h
		Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. habil. Christoph Böhmer

Lecturers

Prof. Dr. habil. Christoph Böhmer

Teaching contents

Lecture:
nucleic acids; introduction to proteins: the primary level of protein structure; the three-dimensional structure of proteins; protein function and evolution; carbohydrates: sugars, saccharides, glycans; lipids, membranes, and cellular transportation; enzymes: biological catalysts; basics of bioinformatics

Lab course:
qualitative and quantitative analysis of biomolecules: nucleic acids, protein and carbohydrates; chromatographic methods; electrophoresis; analysis of Enzyme kinetics; recombinant DNA methods; sequence retrieval and analysis; application of molecular biology software

Learning objectives

On successful completion of this module, students should

- know the basic concepts of biochemistry, be familiar with the technical terms and be able to apply both to given problems[1-3]
- be able to conduct experimental work and to document and to interpret the results[1-5]
- comprehend the correlations of structure and function[1,2,5]
- be able to handle simple bioanalytical lab operations[1-5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; lab course with lab protocols

Entrance requirements

Mandatory:

Recommended: Fundamentals of Chemistry (BE 1 4209); Cell Biology and Microbiology (BE 1 4211)

Reading list

Berg, Tymoczko and Stryer: Biochemistry
Voet and Voet: Biochemistry
Cox and Nelson: Lehninger Principles of Biochemistry
Roberts, Raff and Lewis: Molecular Biology of the Cell
Matthews: Biochemistry

Examination in summer term 2027

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; overhead projector; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 2 4232 Bioengineering Physics II

Study Semester: **2** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	40 h
Exercise	30 h	Literature review	10 h
Lab course	15 h	Preparation for exams	25 h
Sum	75 h	Sum	75 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

Prof. Dr. Björn Neu

Teaching contents

Lecture/Exercises:
This lecture provides a comprehensive introduction to key physics topics, focusing on classical and modern concepts. The course begins with electricity and magnetism, covering electric and magnetic fields. Optical waves are discussed, including wave properties of light and fundamental principles of wave optics. The lecture then introduces the special theory of relativity. Following this, students are introduced to quantum theory, exploring foundational ideas in quantum mechanics, particularly the behavior of atoms and subatomic particles. The course concludes with an overview of nuclear physics, covering the structure of the nucleus and basic nuclear interactions.

Lab course:
This lab course provides hands-on experience with key experiments in physics, including geometric optics, charge-to-mass ratio measurement, wave optics, and thermal radiation. Emphasis is placed on data analysis and the scientific presentation of results, helping students develop essential skills in interpreting and communicating experimental data.

Learning objectives

On successful completion of this module, students should

- have achieved an understanding of the principles of electricity and magnetism and modern physics[1,2]
- be equipped with analytical skills for solving problems in bioengineering[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises; lab course with lab report

Entrance requirements

Mandatory:

Recommended: Bioengineering Physics I (BE 1 4212)

Reading list

Giancoli; Physics for Scientists and Engineers
Zinke-Allmang; Physics for the Life Sciences

Examination in summer term 2027

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 2 4233 Applied Microbiology

Study Semester: **2** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	45 h
Lab course	30 h	Literature review	20 h
		Preparation for exams	25 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Prof. Dr. Joachim Fensterle

Teaching contents

Lecture:
microbial metabolism: autotrophy, heterotrophy, fermentation pathways, energy metabolism; microbial growth: basic growth requirements, media, growth kinetics in static cultures; bacteria and environment: analyzing microbial communities, biofilms, environmental habitats, symbiosis, animal and plants as habitats; nutrient cycles and biodegradation; infection biology and vaccines: molecular biology of infection, host immunity, vaccines including COVID vaccines, selected pathogens; introduction to environmental biotechnology and pharmaceutical biotechnology

Lab course:
microbial methods: culture techniques, determining cell numbers and cell masses (total cell counts, CFU, OD600, dry cell mass); growth kinetics of a bacterial culture; isolation of bacteria: isolation of luminescent bacteria from sea fish; product formation: comparison of different fermentation types of yeast and production of ethanol and glycerol; metabolism: homo- and heterofermentative lactic acid bacteria; analytics: analytics of metabolites

Learning objectives

On successful completion of this module, students should

- know the importance of microorganisms in biotechnology[1]
- have expanded their knowledge of distribution, characteristics and biotechnological and medical relevance of microorganisms[1,2]
- be able to recognize microorganisms as capable and efficient production systems for valuable chemical compounds and pharmaceuticals[1,2]
- understand and apply basic biotechnological processes, in particular with respect to the metabolism of the selected microorganism[2,3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; lab course with lab protocols

Entrance requirements

Mandatory:

Recommended: Cell Biology and Microbiology (BE 1 4211)

Reading list

Fensterle: Biotechnologie für Dummies
Madigan, Martinko, Stahl and Clark: Brock Biology of Microorganisms
Glazer: Microbial Biotechnology: Fundamentals of Applied Microbiology
Antranikian: Angewandte Mikrobiologie
Thieman and Palladino: Introduction to Biotechnology

Examination in summer term 2027

graded exam: electronic written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; overhead projector; flipchart; visualisation aids for presentation; demonstration material; flipped-classroom elements with self assessments (bonus points)

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 20246

BE 2 4234 Applied Mathematics

Study Semester: **2** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Exercise	30 h	Literature review	20 h
		Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Lecturers

Prof. PD Dr.-Ing. Sylvia Moenickes

Teaching contents

Linear algebra (Linear systems of equations; Vector analysis, esp. linear combinations, scalar and vector product matrices, determinants, inverse, eigenvalues); analytic geometry (straight lines and planes in space, polar coordinates); multivariate functions (differentiation, partial derivatives, gradient, total differential, integration); ordinary differential equations, esp. slope field, Euler method, separation of variables, integrating factor, second order linear differential equations, partial differential equations, e.g. diffusion, systems of ordinary differential equations

Learning objectives

On successful completion of this module, students should

- know advanced mathematical concepts and methods, in particular work with multivariate functions and modeling with differential equations[1,2]
- be able to recognize the additional benefit of mathematics: mathematical formulation and processing of a problem deliver additional insights, which might have been missed[2]
- have improved their social competence by group homework and trained their communication skills with the help of exact mathematical formulation[2,3]
- have improved problem-solving thinking via doing their homework[3,4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Mathematics (BE 1 4205)

Reading list

Stewart: Calculus
Stewart: Calculus – Early Transcendentals. Metric International Version
Williams: Linear Algebra
Strang: Linear Algebra and 1st Application (video lecture, see: http://www.mit.edu -> OpenCourseWare [or via iTunes U])
Mattuck: Differential Equations. Video recording of a lecture at MIT, http://www.mit.edu → OpenCourseWare [or via iTunes U]

Examination in summer term 2027

graded exam: 1. written exam, 120 minutes; 2. assignments

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 3 4245 Data Analysis and Applied Statistics

Study Semester: **3** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	30 h	Preparation for contact time	20 h
Project	30 h	Literature review	10 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Lecturers

Prof. PD Dr.-Ing. Sylvia Moenickes

Teaching contents

Probability theory, random variables, probability distributions, law of large numbers; descriptive statistics: levels of measurement, measures of local tendency, of dispersion, graphical representations; inferential statistics: correlation, hypothesis testing; univariate, multivariate regression analysis; analysis of variance, post-hoc test; parameter estimation, confidence intervals, Bayesian inference, time series

Learning objectives

On successful completion of this module, students should

- understand[1] and provide[3] quantitative and visual summaries on data sets
- be able to identify[2] underlying probability distributions
- be able to judge determinations, correlations and information through regression analyses[2,3]
- be able to estimate parameters[3] and test hypotheses[3]
- be able to analyse time series[3]
- be able to apply statistical methods on the analysis of biological data
- be able to apply computer-assisted analysis of large data sets and spectral data

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises; project work

Entrance requirements

Mandatory:

Recommended: Mathematics (BE 1 4205)

Reading list

Field: Discovering Statistics using R, Sage
Delore: Statistics for Scientists and Engineers, Pearson
Veaux: Stats: Data and Models
Bulmer: Principles of Statistics
Attaway: MATLAB – A Practical Introduction to Programming and Problem Solving
Moler: Numerical Computing with MATLAB (http://www.mathworks.de/moler/index_ncm.html)

Examination in winter term 2026/27

graded exam: written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 3 4251 Physical Chemistry

Study Semester: **3** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Exercise	15 h	Literature review	20 h
Lab course	15 h	Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

Prof. Dr. Björn Neu

Teaching contents

Lecture/Exercises:
This module covers fundamental concepts in physical chemistry. Topics include the ideal gas law and the Laws of Thermodynamics, providing a foundation for understanding energy transformations in chemical systems. The Boltzmann Distribution and concepts of enthalpy, including enthalpy of formation, are introduced to explain molecular energy distributions and reaction energetics. Students will explore the Carnot engine, entropy, and free energy to understand efficiency and spontaneity in thermodynamic processes. Additionally, the module delves into chemical potential and reaction kinetics, examining the rates and mechanisms of chemical reactions.

Lab course:
This laboratory practicum covers fundamental experiments, including the ideal gas law, kinetics, boiling point elevation, boiling diagram, and enthalpy. A key focus is placed on data analysis and the scientific presentation of measured data, equipping students with practical skills in experimental evaluation and reporting.

Learning objectives

On successful completion of this module, students should

- understand the basic theories and methods of physical chemistry[1,2]
- be able to analyze and interpret processes and data with the aid of physicochemical models[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises; lab course with lab reports

Entrance requirements

Mandatory:

Recommended: Bioengineering Physics I (BE 4212); Bioengineering Physics II (BE 2 4232)

Reading list

Tinoco, Sauer, Wang and Puglisi: Physical Chemistry. Principles and Applications in Biological Sciences
Atkins and de Paula: Physical Chemistry for the Life Sciences

Examination in winter term 2026/27

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 3 4252 Instrumental Analytics

Study Semester: **3** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Exercise	30 h	Literature review	20 h
		Preparation for exams	40 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Mònica Palmada Fenés

Lecturers

Prof. Dr. Mònica Palmada Fenés

Teaching contents

Lecture:
Principles and applications of most important methods; basics of spectroscopy; UV/VIS-spectroscopy/ spectrophotometry; vibrational spectroscopy: infrared and Raman spectroscopy; molecular fluorescence spectroscopy; chromatography: HPLC, DC, GC; mass spectrometry; nuclear magnetic resonance spectroscopy (NMR)

Exercises:
Determination of analytes' concentration by UV/Vis-spectrophotometry using calibration curves, determination of equilibrium constant and equivalence point by spectrophotometry, analysis of UV/Vis, IR, Raman and NMR spectra, interpreting mass spectrometric data, demonstration of chromatographic techniques

Learning objectives

On successful completion of this module, students should

- know the theoretical basis of various spectroscopic, chromatographic and further instrumental analysis methods[1]
- be able to select appropriate methods in order to solve a given analytical task[2,3]
- be able to understand and to estimate the opportunities of new analytical methods[2]
- be able to analyze and to judge measurement results[4,5]
- be able to analyze UV/Vis, IR, Raman and NMR spectra [4,5]
- be able to interpret mass spectrometry data[2,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; exercises

Entrance requirements

Mandatory:

Recommended: Fundamentals of Chemistry (BE 1 4209); Bioengineering Physics I (BE 1 4212); Applied Chemistry (BE 2 4227)

Reading list

Harris: Quantitative Chemical Analysis
Skoog, Holler and Crouch: Principles of Instrumental Analysis

Examination in winter term 2026/27

graded exam: written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 3 4253 Measurement and Control Engineering

Study Semester: 3 **Credit Points (ECTS): 5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	20 h
Exercise	15 h	Literature review	25 h
Lab course	15 h	Preparation for exams	45 h
Sum	60 h	Sum	90 h

Total workload: 150 h

Module coordinator

Prof. Dr.-Ing. Frank Platte

Lecturers

Prof. Dr.-Ing. Frank Platte

Teaching contents

Lecture and exercise: tasks, history, goals and application of measurement and control engineering; mathematical modeling of technical systems using differential equations; Introduction to physical computing, description of a system with a block diagram; operating mode framework of control cycles; properties of control cycles: linear and non-linear systems; linearization, systems with concentrated/distributed parameters; time-variant and time-invariant systems; causal and non-causal systems; description of linear continuous systems in the time domain: unit-step response, unit-impulse response, convolution integral (Duhamel's integral); description of linear continuous systems in the frequency domain: Laplace transform, transfer function, frequency response plot, Nyquist plot, Bode diagram; dynamic and steady state behavior of linear continuous control systems; stability of linear continuous control systems: definition of stability and stability condition, Routh-Hurwitz criterion, Nyquist criterion, root locus curve; design process for linear continuous control systems, Ziegler-Nichols method.

Lab course: analysis and synthesis of control loops using Matlab/Simulink and ARDUINO; Light intensity control, temperature control, water level control, position control (ball-plate)

Learning objectives

On successful completion of this module, students should

- know how to describe mathematically and to control technical systems as well as to depict them in block diagrams[1,2]
- be able to analyse and to judge mathematically described time-continuous single-parameter control systems to allow the design a control unit according to given specifications with respect to stationary and dynamic behaviour[3,4]
- be able to derive demands to the measurement engineering[4,5]
- have gained experience with computer-based development tools, in particular Mat-lab/Simulink, to be able to conduct practice-oriented descriptions, calculations, and analyses[3,4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Mathematics (BE 1 4205); Bioengineering Physics I (BE 1 4212), Applied Mathematics (BE 2 4234)

Reading list

Nise: Control Systems Engineering, 2022
Franklin, Powell, Emami, Feedback Control of Dynamic Systems, 2019
Atherton: Control Engineering – An introduction with the use of Matlab (free download: https://kosalmath.files.wordpress.com/2010/08/control-engineering-matlab.pdf)

Examination in winter term 2026/27

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material, ARDUINO

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 3 4254 Process Engineering

Study Semester: **3** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	15 h
Exercise	30 h	Literature review	15 h
Lab course	15 h	Preparation for exams	45 h
Sum	75 h	Sum	75 h

Total workload: **150 h**

Module coordinator

Prof. Dr.-Ing. Frank Platte

Lecturers

Prof. Dr.-Ing. Frank Platte

Teaching contents

Lecture:
Chemical reactors: continuous and discontinuous operation of ideal reactors (Batch reactor (BR), semi-batch reactor (SBR), plug flow reactor (PFR), continuously stirred tank reactor (CSTR)), reactor and reaction type, mass balance, evaluation criteria for operating performance of chemical reactors (capacity, conversion rate, selectivity, yield rate, space-time-yield); Reaction kinetics of homogeneous reactions: reaction equation, chemical reaction rate, extent-of-reaction, approach for reaction-kinetic equation (irreversible, equilibrium reaction), temperature dependence of rate constants, determination of reaction rate; Ideal reactors with and without heat of reaction: stoichiometric addition of components, addition of component in excess, comparison of sizes of ideal reactors; Connection of ideal reactors: cascade of stirred reactors and plug flow reactors (analytical, graphical solution), upstream reactor and separation unit; Non-ideal reactors; Influence of heat of reaction: reaction enthalpy (heat of reaction), energy balance, Adiabatic operation, Heat effects, continuous operation (stationary working point, stability of continuously operated stirred reactor, hysteresis (multiple steady states); Optimal temperature control of reversible, exothermal reactions: ideal stirred reactor, continuous operation, Residence time distribution of real reactors.

Fluid properties, Newtonian and non-Newtonian fluids, fluid statics; fluid flow: flow phenomena, two-phase flow systems, Use and benefits of computational fluid mechanics (CFD)

Lab course:
saponification in a BR, CSTR and PFR; measurements of residence time distribution (RTD) and dispersion effects; Single and multi-phase flow in microreactors

Learning objectives

On successful completion of this module, students should

- know the different types of chemical reactors and be able to select the appropriate reactor type for a given reaction[1,2,3]

- know the basics of the kinetics and thermodynamics of the reactions proceeding to the desired product[1,2]
- be able to apply the different connection types of ideal reactors[2,3]
- be able to calculate the non-ideal flow through reactors and the residence time in the reactor[3]
- know relevant parameters and are able to apply them in reactor design[3,5]
- be able to consider the influence of the reaction enthalpy in their calculation[3,4]
- know how to devise the temperature control in a reactor[4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises; lab course with lab reports

Entrance requirements

Mandatory:

Recommended: Mathematics (BE 1 4205); Fundamentals of Chemistry (BE 1 4209); Bioengineering Physics I (BE 1 4212), Applied Mathematics (BE 2 4234)

Reading list

Levenspiel and Octave: Chemical Reaction Engineering, 2021 (Indian Adaption)
Fogler and Scott: Elements of Chemical Reaction Engineering, 2020 (international Edition)

Examination in winter term 2026/27

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 3 4255 Current Topics in Biology

Study Semester: **3** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	30 h	Preparation for contact time	35 h
Project	30 h	Literature review	35 h
		Preparation for exams	20 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Diplôme d'Ingénieur Ralf Lucassen

Teaching contents

The course comprises two parts: "Development of a Research Project" and the corresponding scientific discussions. In essence, the course entails the simulation of a genuine scientific research and/or R&D scenario.

Based on the latest scientific literature, students will develop a research project proposal that includes a budget, funding sources, ethical considerations, social implications, and political aspects. To facilitate dynamic engagement among project teams, the course will be structured around a defined theme, such as the diagnosis and treatment of disease. This will provide a platform for discussing cutting-edge developments in biology. To complement this, live talks with leading scientists and experts will be arranged where feasible. At the conclusion of the course, each project group will present their proposal to their fellow students and a panel of researchers from the faculty, who will act as a "funding jury."

Learning objectives

On successful completion of this module, students should

- know different possibilities of funding and the structure of grant applications[1]
- be able to follow and discuss presentations of current state of the art[2,3,4,5]
- be able to organise and manage a project and group work according to project management principles[2]
- be able to develop a mode to evaluate and document scientific results[3]
- be able to summarize and explain the results and findings in a presentation and respond to critical questions[4]
- be able to critically discuss their findings[5]
- be able to consider the social, environmental and ethical impact of professional decisions[2,3] and thus deepen their capacity to engage in society[2,3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Seminar; self-study; group work; project

Entrance requirements

Mandatory: None

Recommended:

Reading list

This list gives examples of papers used in this course. However, the list is constantly updated depending on the topics that are discussed.

Zackrisson, S., S M W Y van de Ven and S.S. Gambhir. Light in and sound out: emerging translational strategies for photoacoustic imaging. *Cancer research* 74 4 (2014): 979-1004.

Kodosaki E, Watkins WJ, Loveless S, Kreft KL, Richards A, Anderson V, Hurler L, Robertson NP, Zelek WM, Tallantyre EC. Combination protein biomarkers predict multiple sclerosis diagnosis and outcomes. *J Neuroinflammation*. 2024 Feb 17;21(1):52.

Zhu L, Huang B, Wang X, Ni F, Ao M, Wang R, Zheng B, Chen C, Xue J, Zhu L, Yang C, Shi L, Geng S, Hu J, Yang M, Zhang D, Yang P, Li M, Li Y, Hu Q, Ye S, Zheng P, Wei H, Wu Z, Zhang L, Wang Y, Liu Y, Wu X. Highly potent and broadly neutralizing anti-CD4 trimeric nanobodies inhibit HIV-1 infection by inducing CD4 conformational alteration. *Nat Commun*. 2024 Aug 13;15(1):6961.

Oh JH, Kwon JH, Kim HH, Lee J. One-step-immunoassay of procalcitonin enables rapid and accurate diagnosis of bacterial infection. *RSC Adv*. 2021 Jun 17;11(35):21375-21383.

Perju A, Wongkaew N. Integrating high-performing electrochemical transducers in lateral flow assay. *Anal Bioanal Chem*. 2021 Sep;413(22):5535-5549.

Irvine EB, Nikolov A, Khan MZ, Peters JM et al. Fc-engineered antibodies promote neutrophil-dependent control of Mycobacterium tuberculosis. *Nat Microbiol* 2024 Sep;9(9):2369-2382.

Ghazi B, El Ghanmi A, Kandoussi S, Ghouzlani A and Badou A (2022) CAR T-cells for colorectal cancer immunotherapy: Ready to go? *Front. Immunol*. 13:978195.

Rissiek B, Koch-Nolte F, Magnus T. Nanobodies as modulators of inflammation: potential applications for acute brain injury. *Front Cell Neurosci*. 2014 Oct 21;8:344.

Rissiek B, Koch-Nolte F, Magnus T. Nanobodies as modulators of inflammation: potential applications for acute brain injury. *Front Cell Neurosci*. 2014 Oct 21;8:344.

Sun, Z.; Zhang, X.; So, K.-F.; Jiang, W.; Chiu, K. Targeting Microglia in Alzheimer's Disease: athogenesis and Potential Therapeutic Strategies. *Biomolecules* 2024, 14, 833.

Dyussembayev K, Sambasivam P, Bar I, Brownlie JC, Shiddiky MJA and Ford R (2021) Biosensor Technologies for Early Detection and Quantification of Plant Pathogens. *Front. Chem.* 9:636245.

Chaudhary N, Weissman D, Whitehead KA. mRNA vaccines for infectious diseases: principles, delivery and clinical translation. *Nat Rev Drug Discov*. 2021 Nov;20(11):817-838.

Additional resources (videos, websites, etc.) will be provided during the course.

Examination in winter term 2026/27

certificate: 1. presentation of scientific project with Q&A session; 2. presentation

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence		X	
Methodological competence		X	
Social competence	X		

last amended: May 2026

BE 4 4274 Project

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
project	10 h	Preparation for contact time	90 h
Discussions	10 h	Literature review	10 h
group work	20 h	Preparation for exams	10 h
Sum	40 h	Sum	110 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

N.N. (coordination); all lecturers of the faculty

Teaching contents

Organization of projects as part of a knowledge-based education; structuring of tasks; collection and analysis of relevant academic literature; acquisition of social competence and ability to work in a team; acquisition and deepening of subject-specific knowledge and methods; writing of academic texts; adequate presentation of results by way of posters, reports or presentation

Learning objectives

On successful completion of this module, students should

- know and apply methods of academic writing to a project relevant to the study course[3]
- have acquired and broadened their discipline-specific knowledge[1,3,4]
- be able to define the relevant project phases on the basis of the project's subject and to define an appropriate project organisation[1]
- be able to collect the relevant data and to discuss the information in their group[2]
- be able to detect multidisciplinary contexts and to apply if necessary knowledge and methods in an interdisciplinary, but always problem- and/or goal-oriented way
- be able to work independently as well as in a team and have experienced requirements and options of leadership without disciplinary authority[2]
- be able to analyze the scientific/academic and societal relevance of the results for the achievement of the project's goal[4]
- be able to summarize the results of the project in a written report and prepare the presentation to the study course group[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

group work; project; discussion; contact time; presentation

Entrance requirements

Mandatory:

Recommended: International Project Management (BE 1 4213); modules of terms 1–3 depending on selected topic

Reading list

Wilson: An introduction to Scientific Research
Carey: A Beginner's Guide to Scientific Method
Valiela: Doing Science: Design, Analysis, and Communication of Scientific Research
Kahn: The Student's Guide to Successful Project Teams
APittampalli: Read This before Our Next Meeting
Horine: Project Management Absolute Beginner's Guide
Portny: Project Management for Dummies
Alley: The Craft of Scientific Presentations: Critical Steps to Succeed and Critical Errors to Avoid
Hofmann: Scientific Writing and Communication: Papers, Proposals, and Presentations
Alley: The Craft of Scientific Writing

Depending on topic scientific literature will be provided by instructor.

Examination in summer term 2027

certificate for project work, depending on project chosen

Teaching materials and media

Beamer; white/black board; flipchart; visualization tools (facilitator's toolcase); AV-media; overhead projector; demonstration material; library

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence		X	
Methodological competence	X		
Social competence	X		

last amended: May 2026

BE 4 4277 Bioprocess Engineering

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	45 h
Lab course	30 h	Literature review	20 h
		Preparation for exams	25 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Prof. Dr. Joachim Fensterle

Teaching contents

Lecture:
introduction, historical background, structure of bioprocesses; balancing bioprocesses: material and energy balances, unsteady state balances; mass transfer: mass transfer in bioprocesses, oxygen transfer; kinetics: basic reaction theory, yields, growth, production kinetics and kinetics of substrate uptake, determining parameters from experimental data; reactor engineering: reactor configurations, operation modes: stirred tank reactors: batch, fed batch, continuous; other reactor designs; reactor sterilization and operation; process control and instrumentation

Lab course:
simulation: determining oxygen transfer rates; simulation: determining optimal operation conditions for a fed batch process; assessing and calculating kinetic parameters (substrate consumption, product formation, cell growth) in an anaerobic fermentation process using real-time measurement of gas and ethanol formation; aerobic continuous culture (chemostat) of yeast at different dilution rates; determining oxygen transfer rates in a lab-scale bioreactor.

Learning objectives

On successful completion of this module, students should

- know the design and range of application of bioreactors and understand different bioprocess control variants[1,2]
- understand the basics of material and heat transfer in bioreactors[1,2]
- be able to balance the material and energy transfer in a bioprocess[3]
- know the scale-up parameters and to be able to apply them in a scale-up process[1,3]
- be able to describe mathematically the growth of microbial cultures and gain basic knowledge with respect to modeling of microbial growth and product formation[2,3]
- be able to apply analysis methods like measurement of optical density (OD), bio dry mass, substrate and (by-) product analyses[1,2]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; group work; self-study; lab course with lab protocols

Entrance requirements

Mandatory:

Recommended: Applied Microbiology (BE 2 4233); Applied Mathematics (BE 2 4234); Process Engineering (BE 3 4254)

Reading list

Fensterle: Biotechnologie für Dummies
Doran: Bioprocess Engineering Principles
Shuler and Kargi: Bioprocess Engineering: Basis Concepts
Chmiel: Bioprozesstechnik
Haas: Praxis der Bioprozesstechnik mit virtuellem Praktikum

Examination in summer term 2027

graded exam electronic written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 4 4278 Enzyme Engineering

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	45 h
Seminar	15 h	Literature review	20 h
Exercise	15 h	Preparation for exams	25 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Mònica Palmada Fenés

Lecturers

Prof. Dr. Mònica Palmada Fenés

Teaching contents

Lecture:
Enzymes: classification, mechanisms, kinetics; technical relevant enzymes: hydrolases, isomerases, oxidoreductases, transferases; enzyme production: production systems, export (prokaryotes), inclusion bodies; protein folding and maturation; protein immobilization; immobilized protein imprinting; rational design of enzymes; directed evolution methods: error prone PCR (epPCR), DNA shuffling, Sequence Saturation Mutagenesis (SeSaM); high-throughput screening (HTS); phage-display

Exercises/Seminar:
Determination of enzyme kinetic parameters; analysis and strategies for identification of enzyme inhibitor types; students' seminar on technical application of enzymes; reading, presentation and discussion of research papers on enzyme improvement

Learning objectives

On successful completion of this module, students should

- deepen their knowledge on enzymes[1,2]
- know the methods to obtain kinetic parameters of enzymes[1,2,3]
- be able to interpret and analyze enzyme-kinetic data[4,5]
- have gained insights in technical application of enzymes and the reasons for enzyme improvement[1,3]
- understand the principles of the various rational design and directed evolution methods to obtain protein libraries[1,2]
- be able to select the appropriate methods for a given protein engineering task[4.5]
- be capable to critically interpret experimental data from primary literature[2,3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Genetics and Molecular Biology (BE 2 4230); Biochemistry (BE 2 4231); Instrumental Analytics (BE 3 4252)

Reading list

Park and Cochran: Protein Engineering and Design
Sheehan: Protein Engineering: Design, Selection and Applications
Koehrer and RajBhandary (eds.): Protein Engineering
Arndt and Müller: Protein engineering protocols

Examination in summer term 2027

graded exam electronic written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 4 4279 Bioinformatics

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	20 h
Seminar/Project	30 h	Literature review	10 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr.-Ing. Frank Platte

Lecturers

Prof. Dr. Henrik Rudolf

Teaching contents

Basics of programming (data types; decision making; operators, loops, functions, databases management); Database search algorithms such as regular expressions; Algorithms for sequence analysis and genomics: Introduction to web-based algorithms (speed, reliability); image analysis (segmentation, size estimators, classification); analysis of spectral data (feature extraction, database search)

Project: In the project, students will apply their knowledge to solve a bioinformatics question using Matlab or an AI system.

Learning objectives

On successful completion of this module, students should

- understand[1] and provide[3] quantitative and visual summaries on data sets
- have learnt basics of programming[2,3]
- be able to search algorithms e.g. finding scientific papers[2,3]
- be able to analyse images and spectral data[3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Mathematics (BE 1 4205); Data Analysis and Applied Statistics (BE 3 4245)

Reading list

Bioinformatics Algorithms: An Active Learning Approach,
Merkel, Waack, Bioinformatik interaktiv
Strang: Scientific computing (see http://www.mit.edu -> OpenCourseWare)
Kaplan: Introduction to Scientific Computation and Programming
Attaway: MATLAB – A Practical Introduction to Programming and Problem Solving

Examination in summer term 2027

graded exam: 1. written exam (40%); 2. scientific report (20%); 3. mini projects (30%); 4. practicals checkpoints (10%)

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 4 4301 Technical Enzymology and Biocatalysis (elective module)

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	60 h	Preparation for contact time	30 h
		Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Mònica Palmada Fenés

Lecturers

Prof. Dr. Mònica Palmada Fenés

Teaching contents

Technical Enzymology: Application of enzymes in industry: food and beverage enzymes; feed enzymes; paper and pulp industry; starch industry; household care enzymes/detergent industry; textile industry; bioenergy enzymes; leather industry; enzymes for processing of fats and oils

Biocatalysis: Characteristics of biocatalysis; applications in industry; green chemistry; enantiomerically pure compounds; activity, selectivity and stability of enzymes; basic and fine chemicals including pharma intermediates and semi-synthetic antibiotics; biocatalysis in non-aqueous media (organic solvents, ionic liquids); stability of proteins

Learning objectives

On successful completion of this module, students should

- have basic knowledge on the industrial application of enzymes[1,2]
- know the different types of enzymes employed in the dairy industry and judge their usability[1,2]
- research a leading-edge application of enzyme technology and present and discuss the results in an oral presentation[4,5]
- know how enzymes are used in industry for production of chemical products[1,2]
- be able to explain enzyme-catalysed processes for production of enantomerically pure compounds and suggest strategies for stereoselective synthesis optimization[2,3,4.5]
- know the pros and cons of different reaction media for enzymatic reactions and decide which media is appropriate for a specific application[4,5]
- be able to apply knowledge from molecular biology, biochemistry and applied chemistry courses to design biologically-based methods for the synthesis of a chemical compound of interest, and present and discuss them in an oral presentation[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and oral presentation

Entrance requirements

Mandatory: None

Recommended: Applied Chemistry (BE 2 4227); Biochemistry (BE 2 4231); Enzyme Engineering (BE 4 4278)

Reading list

Aehle: Enzymes in Industry: Production and Applications
Polaina and MacCabe: Industrial enzymes: structure, function and applications
Bommarius and Riebel: Biocatalysis: Fundamentals and Applications
Faber: Biotransformations in Organic Chemistry

Further literature will be provided by the lecturer.

Examination in summer term 2027

graded exam 1. written exam, 120 minutes; 2. presentation

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; pin-board; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 4 4302 Agricultural Biotechnology and Biofuels (elective module)

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	30 h	Preparation for contact time	30 h
Project	30 h	Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Dr. Wael Sabra; Prof. Dr. Matthias Kleinke

Teaching contents

Agricultural Biotechnology: Breeding, selective breeding, plant transgenics, cloning, antisense and gene silencing selected applications for pharmacology, plant technology or enhanced nutrition, regulatory issues, perception and concerns in Europe and US

Biofuels: Renewable energy sources compared to fossil resources, biomass feedstock and intermediates of biofuels, properties and utilisation, production processes: conventional and lignocellulosic ethanol and methanol production, hydrogen from biomass, biodiesel production, solid biomass, combustion, carbonisation and gasification of biomass, anaerobic fermentation, production costs of biofuels, GHG emissions, sustainability of biofuel production and utilisation

Learning objectives

On successful completion of this module, students should

Agricultural Biotechnology

- know the principles of transgenic plant technology[1]
- be able to name and describe selected examples[1]
- know relevant regulations[1]
- be able to defend pro- or con- positions based on rational arguments[2,4,5]

Biofuels

- be prepared to identify energy potentials of biofuels[1]
- know the properties of the most common biofuels and their demands[1]
- have an overview about biomass resources, the biofuel production processes as well as their energetic, economic and ecological aspects[1,2]
- be able to judge on the economic feasibility of biofuel usage[1,2,3]
- be able to evaluate the use of biofuels in terms of its sustainability[1,2,3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and presentation

Entrance requirements

Mandatory: None

Recommended:

Reading list

Thiemann: Introduction to Biotechnology
Neal: Plant Biotechnology and Genetics: Principles, Techniques and Applications

Gomez Castro: Biofuels and Biorefining
Lee, Sunggyu: Biofuels and Bioenergy
Luque: Handbook of Biofuels Production

Examination in summer term 2027

graded exam 1. written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; pin-board; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence		X	
Social competence			X

last amended: May 2026

BE 4 4303 Nanobiotechnology (elective module)

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	60 h	Preparation for contact time	30 h
		Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Coordinator

Prof. Dr. Kerstin Koch

Instructors

Prof. Dr. Kerstin Koch

Contents

The seminar is organized in three blocks. The first provides the basics of nanotechnology such as definition, history, mile stones; production techniques; bottom up and top-down techniques; microscopy techniques and properties of nanomaterials. The second part focuses on nano-bio-technology and includes diagnostics and therapy and drug delivery; nanostructured materials in regenerative medicine; analytical applications; nanoparticles and health risks; nano in food technology. The third part is related to applied fields of nanotechnology, such as nanotechnology and water cleaning; nanotechnology and the environment and future perspectives.

Intended learning outcomes

On successful completion of this module, students should

- know the main fields of nanotechnology use[1]
- be able to discuss the advantages and potential risk on nanomaterial use[2]
- know examples of nanomaterial's and their specific attributes and applications[1]
- have improved their communication and presentation competence[3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Seminar with self-study; group work and student presentations

Entrance requirements

Mandatory: None

Recommended: Cell Biology and Microbiology (BE 1 4211); Fundamentals of Chemistry (BE 1 4209); Bioengineering Physics I (BE 1 4212)

Reading list

Manasi Karkare: Nanotechnology: Fundamentals and Applications
Nanomaterials and Tissue Regeneration Open Access Journal
Nanoscape: The Journal for Undergraduate Research in Nanoscience Open Access Journal

Examination in summer term 2027

graded exam 1. written exam, 60 minutes; 2. seminar presentation and summaries during the semester

Teaching materials and media

Beamer; visualisation aids for presentation

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence		x	

last amended: May 2026

BE 4 4304 Fluid Mechanics and Dynamical Systems (elective module)

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	15 h	Preparation for contact time	30 h
Seminar	15 h	Literature review	30 h
Lab course	30 h	Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Lecturers

Dr. Peter Henselder; Prof. PD Dr.-Ing. Sylvia Moenickes

Teaching contents

Fluid Mechanics: Basics: Fundamental fluid (liquids and gas) properties, Newtonian and non-Newtonian fluids, compressible and incompressible fluids, viscosity measurement, fluid statics; fluid flow: equations of motion for inviscid flows, flow phenomena, similitude; piping, seals, and valves: friction and piping, gaskets and mechanical seals, valves; flow measurement: pumps ejectors, blowers, and compressors; mixing; two-phase flow systems

Systems dynamics: Continuous models based on differential equations, compartment schemes, superposition; steady states and stability of systems, sensitivity; models in time and space

Programming is accomplished in Matlab

Learning objectives

On successful completion of this module, students should

Fluid Mechanics

- know the basic properties of fluids[1,2]
- be able to use the different types balance equations[1,2,3]
- be able to determine shear rates and their effect on cells[1,2,3]
- be able to determine hydrostatic pressure distribution in non-flowing fluids[1,2,3]
- be able to calculate pressure drops of complex networworks[2,3,4]

Systems dynamics

- know how to mathematically describe dynamic processes[1]
- be able to set up non-linear multi-compartment models[2,3]
- be able to analyse a given system with respect to stability and sensitivity[5]
- know how to implement such systems in Matlab and run simulations[3,4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and presentation; exercises

Entrance requirements

Mandatory: None

Recommended: Mathematics (BE 1 4205); Bioengineering Physics I (BE 1 4212); Applied Mathematics (BE 2 4234)

Reading list

Potter: Mechanics of Fluids
Fox, McDonald, Pritchard: Fluid Mechanics

Examination in summer term 2027

graded exam: written exam, 120 minutes
certificate for lab course

Teaching materials and media

Beamer; white board; hand-outs; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 4 WPF_1 Module from any Bachelor Study Course at Faculty of Life Sciences at Rhine-Waal University of Applied Sciences

Study Semester: **4** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
	60 h	Preparation for contact time	30 h
		Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

All lecturers of the faculty

Teaching contents

Depending on the chosen module to be elected from all bachelor study courses of the faculty of Life Sciences at Rhine-Waal University

Learning objectives

On successful completion of this module, students should

- have acquired knowledge from other areas of the faculty and deepened or enlarged their horizon[1]
- understand the importance of getting information beyond their specialisation[2]
- be able to implement alternative ways and approaches to problem solving[3]
- be able to compare contents and learning outcomes of other study courses with their own achievements[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Depending on chosen module

Entrance requirements

Depending on chosen module

Reading list

Depending on chosen module

Examination

graded exam: depending on chosen module

Teaching materials and media

Depending on chosen module

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence		X	
Social competence			

last amended: May 2026

BE 5 4324 Integrated Management Systems

AB 5 4124
SA 5 4124

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	15 h	Preparation for contact time	40 h
Seminar	15 h	Literature review	20 h
Exercise	30 h	Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Simone Pauling

Lecturers

Prof. Dr. Simone Pauling

Teaching contents

Historical development of integrated and sustainability management; process orientation; international standards for integrated and sustainability management systems (e.g. ISO 9001, EMAS, ISO 14001, ISO 45001, ISO 19011, ISO 26000, ISO 50000, ISO 14040); methods of system control and evaluation; auditing; stakeholder concept; occupational health and safety, hygiene; quality management; environmental management; risk management (e.g. ISO 31000); process of developing and continuously updating user-oriented sustainability management systems in context of bioengineering; life cycle assessment; management systems and food safety (e.g. Codex Alimentarius, ISO 22000, HACCP); legal requirements in food safety; controlling food safety and regulatory agencies

Learning objectives

On successful completion of this module, students should

- know the components of integrated and sustainability management systems, standards and the legal framework[1]
- be able to apply covered instruments in case studies for system control, evaluation and improvement[2,3]
- be able to develop concepts and strategies for the implementation of integrated management systems[3]
- be able to analyse food safety and product quality using the relevant standards and procedures[3, 4]
- be able to analyse[4] and improve[5] sustainability management systems for sustainable supply chains
- be able to evaluate and critically discuss concepts of integrated and sustainable management[5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; exercise; self-study; group work

Entrance requirements

Mandatory: none

Recommended: none

Reading list

International Standards ISO 9000 ff, 14000 ff, 45001, 19011, 26000, 22000, 14040
Andrews and Pardy: Integrated Management Systems
Zink: Total Quality Management as a Holistic Management Concept
Goetsch: Quality Management for Organizational Excellence: Introduction to Total Quality
Ferret, Hughes and Hughes: International Safety and Health at Work
Hauschild, Rosenbaum and Olsen: Life Cycle Assessment

Examination in winter term 2026/27

graded exam: 1. Assignment; 2. written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material; A/V media; case studies

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence		X	

last amended: May 2026

BE 5 4326 Downstream Processing

Study Semester: **5** (full time) **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	45 h
Seminar	30 h	Literature review	20 h
		Preparation for exams	25 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Dr. Martin Krehenbrink; Dr. Luitpold Fried

Teaching contents

Lecture:
Principles of downstream processing from bio-suspensions; impact of fermentation process on product, pre-treatment of fermentation broth; cell harvest; cell/tissue disruption techniques; filtration; sedimentation, flocculation and centrifugation; product separation techniques: distillation, extraction, adsorption, evaporation; product purification: precipitation, membrane based processes, chromatography, crystallization; product formulation; conservation and storage: lyophilisation, spray drying, freezing, sterile filtration; denaturation and renaturation of proteins (inclusion bodies)

Seminar:
The content of the lectures will be reviewed and discussed using concrete real-world examples of integrated processes. Theoretical approaches to quantify and describe relevant processes will be practiced using worked examples. The selection of appropriate downstream procedures for example products will be practiced in the form of guided exercises.

Learning objectives

On successful completion of this module, students should

- have gained basic knowledge on biotechnological downstream procedures and the required equipment[1,2]
- be able to select appropriate combinations of methods for the recovery of intra- and extracellular products[2,3]
- know theoretical approaches to describe separation processes quantitatively in order to support the evaluation of experimental data[4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory:

Recommended: Biochemistry (BE 2 4231); Bioprocess Engineering (BE 4 4277)

Reading list

Prasad: Downstream Process Technology: A New Horizon in Biotechnology
Scopes: Protein Purification: Principles and Practice
Janson: Protein Purification: Principles, High Resolution Methods, and Applications
Desai: Downstream Processing of Proteins: Methods and Protocols
Storhas: Bioverfahrensentwicklung
Chmiel: Bioprozesstechnik
Fensterle: Biotechnologie für Dummies

Examination in winter term 2026/27

graded exam: written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 5 4327 Industrial Biotechnology

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	45 h
Seminar	30 h	Literature review	20 h
		Preparation for exams	25 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Prof. Dr. Joachim Fensterle

Teaching contents

Lecture:
introduction: scope and impact IB, major historical milestones; industrial system biology: introduction to system biology, metabolic network models, example of applied industrial system biology; production: production organisms, industrial media, equipment, optimization; metabolic pathways and overproduction of metabolites; biocatalysis: introduction, directed evolution, applied biocatalysis; major fields of industrial biotechnology: chemical, pharmaceutical IB, food and feed IB, paper and pulp IB; environmental, economic and social aspects; project in small groups: setting up of an industrial process, including flowchart, in selected fields; analyzing the market, potential market price and definition of a production goal; scaling the process according to the production goal; calculation of process economics (investment costs, process costs, additional costs,…) and rentability

Seminar:
Introduction to the process simulation software SuperPro Designer; setting up a representative industrial biotechnology process (including mass balances) using SuperPro Designer in project groups; optimizing the process and analyzing of economic parameters; presenting the project results in form of an investors' pitch

Learning objectives

On successful completion of this module, students should

- know the topics of industrial biotechnology[1]
- understand how to develop production organisms and production processes[2,3]
- understand the impact of global analysis tools (Omics) on strain and process development[2]
- be aware of ecological and economic aspects of industrial biotechnology[4,5]
- be able to combine the knowledge acquired in biotechnological, engineering and economics disciplines to develop a industrial biotechnological process[3,4,5]
- be able to consider the social impact of professional decisions[2,3] and thus deepen their capacity to engage in society[2,3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; project work; group work; exercises; presentations; written reports

Entrance requirements

Mandatory:

Recommended: Biochemistry (BE 2 4231); Applied Microbiology (BE 2 4233)

Reading list

Fensterle: Biotechnologie für Dummies
Soetaert and Vandamme: Industrial Biotechnology: Sustainable Growth and Economic Success
Baltz, Demain and Davies: Manual of Industrial Microbiology and Biotechnology
Okafor: Modern Industrial Microbiology and Biotechnology
Waits: Industrial Microbiology

Examination in winter term 2027

graded exam: 1. electronic interim assessments during semester or oral exam (please contact lecturer in latter case); 2. project report and oral presentation

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; demonstration material; SuperPro Designer software

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence	X		

last amended: May 2026

BE 5 4351 Metabolic Engineering (elective module)

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	30 h	Preparation for contact time	30 h
Project	30 h	Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Mònica Palmada Fenés

Lecturers

Dr. Georg Lentzen

Teaching contents

Basic principles of metabolic engineering; regulation of metabolic pathways; modelling tools; metabolomics; flux analysis, hosts for metabolic engineering: *E. coli*, yeast, *Bacillus subtilis*, streptomyces, filamentous fungi, mammalian cells

Learning objectives

On successful completion of this module, students should

- understand the principles of enzyme function, stoichiometric analysis and energetics of metabolism[2]
- know several models (steady-state, dynamic) of microbial metabolism and recognize their advantages and disadvantages [1,2]
- be able to develop metabolic network models[3,4,5]
- be able to apply knowledge from molecular biology, biochemistry and applied microbiology courses for the study of metabolism[2,4]
- be able to present and discuss a scientific paper relevant to metabolic engineering[4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and presentation

Entrance requirements

Mandatory: None

Recommended: Biochemistry (BE 2 4231); Applied Microbiology (BE 2 4233); Enzyme Engineering (BE 4 4278)

Reading list

Kholodenko and Westerhoff: Metabolic Engineering in the Post Genomic Era
Wendisch: Amino Acid Biosynthesis – Pathways, Regulation and Metabolic Engineering

Further literature will be provided by the lecturer.

Examination in winter term 2027

graded exam: 1. written exam, 60 minutes; 2. report (one per team)

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; pin-board; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 5 4352 Biological Physics (elective module)

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Lab course	30 h	Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

Prof. Dr. Björn Neu; Dr. Peter Henselder; Timo Preißing, M.Sc.

Teaching contents

Lecture/Seminar:
This course introduces physics and physical chemistry principles and methods as applied to studying biological systems. Key topics include model building in biology to understand complex systems, cell physiology fundamentals, and macromolecular assemblies' structure and function. The course covers thermal motion, diffusion law, and biological applications of diffusion and friction in fluids. Students will explore self-assembly and molecular devices in cells. Additionally, the kinetics of molecular machines and the role of machines within cell membranes are examined, providing insights into the physics underlying cellular processes.

Lab Course:
This part of the course introduces topics and applications in biological/medical physics.

Learning objectives

On successful completion of this module, students should

- understand the basic theories and methods in biological physics[1,2]
- be able to analyse and interpret molecular and cellular biology processes and data with tools of physics and mathematics[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and presentation

Entrance requirements

Mandatory: None

Recommended: Physical Chemistry (BE 3 4251)

Reading list

Nelson: Biological Physics
Phillips: Physical Biology of the Cell

Examination in winter term 2026/27

graded exam: 1. written exam, 60 minutes; 2. oral exam (presentation during seminar)
certificate for lab course

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; pin-board; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 5 4353 Environmental Biotechnology and Microalgae (elective module)

Study Semester: **5** (full time) **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	30 h	Preparation for contact time	30 h
Project	30 h	Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Dr. Wael Sabra

Teaching contents

Environmental Biotechnology and Microalgae: introduction: biomagnification, sublethal effects and concept of stress, grasshopper effect, planetary boundaries, nutrient pollution; mixed culture biotechnology: natural and model community, compartmentalization, advantages of mixed culture, inhibition kinetics, Zwietering model, microbe-microbe interactions, Lotka-Volterra model; air pollution: particulate matter, characterising biofilter performance, bioreactors for air purification; microalgae introduction: prokaryotic and eukaryotic cells, taxonomy of algae, biotechnological application of microalgae, aquaculture, algal blooms; microalgae cultivation; nutrition in microalgae, phototrophic-mixotrophic and heterotrophic growth, photoinhibition, modelling algal growth, photobioreactors, different bioreactors design, challenges of microalgae cultivation; biogas production: benefits of biogas technology, energy balance, environmental concern about biogas, biogas potential measurement, theoretical biogas yield, impurities of biogas; biogas microbiology: major microbial groups involved, interspecies hydrogen transfer, effect of hydrogen partial pressure, hydraulic retention time and substrate loading rate, bioreactor control and prevention of excessive acidification, Biogas upgrading technologies; upgrading using algal-bacterial processes; wastewater treatment introduction: groundwater versus surface water contamination, municipal wastewater, common source of water contamination, preliminary treatment; secondary and tertiary wastewater treatment: high rate algal ponds, trickling filter, rotating disc reactors, activated sludge process, process optimisation, HRT, SRT, OLR, F/M, carbon and nutrient removal, scenarios for N-removal; bioremediation: biodegradation-mineralisation-immobilisation of pollutants, microsom, factors affecting bioremediation, natural attenuation, biostimulation, bioaugmentation, in situ and ex situ bioremediation, slurry bioreactors

Learning objectives

On successful completion of this module, students should

Environmental Biotechnology and Microalgae

- know the principles and complexity of environmental processes[1,2,3]

- be able to describe the interplay between population dynamics, the environmental factors and the ecological interactions in mixed culture[4,5]
- know the major process parameters for operating a biogas plant[3,4,]
- know the principles and steps of a typical wastewater treatment plant and optimisation [2,3,4]
- be able to develop and present a selected environmental biotechnology approach[3,4,5]
- know the diversity of algae and have gained basic knowledge in anatomy, physiology, and growth patterns of algae[1]
- know how to select the appropriate bioreactors for cultivating microalgae[2,3,4]
- Understand the ecological significance of algae in various ecosystems and how this knowledge contributes to environmental conservation.[2,3]
- Understand the conditions necessary for optimizing the production of high-value products from microalgae.[,2,3,4,5]
- to apply the different bioremediation technologies used for soil and water pollution[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and presentation

Entrance requirements

Mandatory: None

Recommended: Applied microbiology (BE 2 4233)

Reading list

Shareefdeen- Biotechnology for Odor and Air Pollution Control
Spellman: Water and wastewater treatment plant operation
Jördening: Environmental Biotechnology
OECD: The Application of Biotechnology to Industrial Sustainability
Deubelein: Biogas from waste and renewable resources
Antranikian: Angewandte Mikrobiologie
Lee: Phycology
Bellinger and Sigee: Freshwater algae: identification and use as bioindicators
Gouveia: Microalgae as a Feedstock for Biofuels
Fensterle: Biotechnologie für Dummies

Examination in winter term 2026/27

graded exam: written exam, 120 minutes

Teaching materials and media

Beamer; white/black board; handouts; flipchart; pin-board; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 5 4354 Pharmaceutical Biotechnology and Immunology (elective module)

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Seminar	30 h	Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

Prof. Dr. Joachim Fensterle

Teaching contents

Pharmaceutical Biotechnology: Definition and introduction into biopharmaceutical products; prokaryotic cells, mammalian cells, plants and transgenic animals as sources for biopharmaceuticals; the drug development process – from discovery to approval; drug approval / regulatory aspects in Europe and USA; GxP.; typical production schemes, downstream processing and analytical processes for protein biopharmaceuticals; gene therapy; selected biopharmaceutical products

Immunology: Overview of the innate and adaptive immune system; haematopoiesis; lymphocyte maturation; somatic recombination; affinity maturation; innate immune system / complement; cytokines; effector mechanisms of cellular and humoral immunity; selected examples of immunity to microbes; tumor immunology including checkpoint-inhibitors and RNA vaccines; autoimmunity; immunodeficiencies

Seminar: analysis and presentation of original immunology publications by groups, discussion of papers

Learning objectives

On successful completion of this module, students should

- know biopharmaceutical products and their sources[1]
- understand the drug development process[1,2]
- know regulatory aspects of development / approval and production[1]
- understand basic production processes[1,2]
- be able to name selected biopharmaceutical products[1,3]
- be able to design a schematic development plan for a biopharmaceutical product[3,4,5]
- know essential components of the innate and adaptive branch of the immune system[1]
- know and describe the processes and kinetics in an adaptive humoral and cellular response[1]
- know, apply and present selected examples of immunity based on original publications[1,2,3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work and presentation

Entrance requirements

Mandatory: None

Recommended: Biochemistry (BE 2 4231), Applied Microbiology (BE 2 4233), Bioprocess Engineering (BE 4 4277)

Reading list

Fensterle: Biotechnologie für Dummies
Kayser: Pharmaceutical Biotechnology – Drug Discovery and Clinical Applications
Walsh: Pharmaceutical Biotechnology – Concepts and Applications.

Examination in winter term 2026/27

graded exam: 1. project presentation as video; 2. oral presentation during semester; 3. electronic interim assessments during semester or oral exam (please contact lecturer in the latter case)

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; pin-board; visualisation aids for presentation; demonstration material

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence		X	
Social competence		X	

last amended: May 2026

BE 5 4355 Biopolymers (elective module)

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Seminar	15 h	Literature review	30 h
Lab Course	15 h	Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

Prof. Dr. Peter F. W. Simon

Teaching contents

Lecture:
Definition of biopolymers, including the most relevant examples; nomenclature of polymers; distribution and averages in polymer sciences including the experimental determination; solid-state behavior of polymers especially thermal properties; synthesis of biopolymers by polycondensation, polyaddition and chain polymerization focusing on the underlying mechanisms, the thermodynamic requirements and expected distribution; application of biopolymers in various areas of everyday life

Lab Course:
Synthesis of model polymers by polycondensation, polyaddition and chain polymerization techniques; coagulation and properties of natural rubber

Learning objectives

On successful completion of this module, students should

- be able to identify and evaluate biopolymer-based materials due to their molecular features[1,2]
- be able to name different approaches to synthesize different types of biopolymer-based materials[3,4]
- be able to suggest suitable methods to analyse the chemical and physical properties of biopolymer-based materials[3,4]
- be able to describe the application of biopolymer-based materials and appreciate their importance in everyday life[5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory: None

Recommended: Mathematics (BE 1 4205); Fundamentals of Chemistry (BE 1 4209); Bioengineering Physics I (BE 1 4212); Applied Chemistry (BE 2 4227); Physical Chemistry (BE 3 4251); Instrumental Analytics (BE 3 4252)

Reading list

Hiemenz and Lodge: Polymer Chemistry
Koltzenburg: Polymer Chemistry
Smidsrod: Biopolymer Chemistry
Fakirov and Bhattacharyya: Engineering Biopolymers

Examination in winter term 2026/27

graded exam: multiple choice exam, 120 minutes
certificate for lab course, based on attendance and laboratory reports

Teaching materials and media

Beamer; white/black board; on-line learning management system (Moodle); demonstration material and experiments

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 5 WPF_2 Module from any Bachelor Study Course at Faculty of Life Science at Rhine-Waal University of Applied Sciences

Study Semester: **5** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
	60 h	Preparation for contact time	30 h
		Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

All lecturers of the faculty

Teaching contents

Depending on the chosen module to be elected from all bachelor study courses of the faculty of Life Sciences of Rhine-Waal University

Learning objectives

On successful completion of this module, students should

- have acquired knowledge from other areas of the faculty and deepened or enlarged their horizon[1]
- understand the importance of getting information beyond their specialisation[2]
- be able to implement alternative ways and approaches to problem solving[3]
- be able to compare contents and learning outcomes of other study courses with their own achievements[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Depending on chosen module

Entrance requirements

Depending on chosen module

Reading list

Depending on chosen module

Examination

graded exam: depends on chosen module

Teaching materials and media

Depending on chosen module

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence		X	
Social competence			

last amended: May 2026

BE 6 4391 Internship or Study Abroad

Study Semester: **6** **Credit Points (ECTS):** **30**

Workload

Contact time	Self-study
Sum	Sum 900 h

Total workload: **900 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

Depends on selected activity

Teaching contents

Internship: Within the internship the students are required to work in one or more functional divisions/branches of a company to implement knowledge and methods acquired during their study courses. The students are requested to consider the coherencies of economic, social and environmental aspects. After finishing the internship, the experience gained must be summarized in a written report according to criteria defined beforehand by the student and the supervising professor. The internship can also be pursued abroad.

Study abroad: As an alternative to the internship the students may choose to study a semester at a university abroad in order to deepen their theoretical and practical knowledge. Modules at the guest university abroad should complement the modules already completed in the own degree programme. The students attend the selected classes and pass the relevant exams. On completion of their study abroad, students should be able to discuss relevant issues in a cross cultural and academic surrounding. Upon agreement of study abroad student and supervisor fix the intended outcomes. After the return experience gained must be summarized in a written report according to criteria defined beforehand by the student and the supervising professor. Upon return from study abroad the supervisor will check the written report based on the following criteria: expectations vs. the achievements actually made, validity of experiences for the studies, active learning, structuring of experiences achieved, effective competence to solve problems in an unfamiliar surrounding. Furthermore, the cross cultural competences should be presented and discussed with the other participants of the study abroad course.

Learning objectives

Internship: The learning outcomes result from the selected activity and the business environment of companies, organisations and institutions. It is necessary that these partners and the university agree on contents and outcomes in order to allow for an appropriate coordination of the study.

Study abroad: The learning outcomes depend on where and how the study abroad is pursued. The student will improve her/his language skills in an authentic surrounding. The student has to coordinate the selection of classes with the supervisor of this module for recognition of assembled ECTS.

- The students learn to consider the social impact of professional decisions[2,3] and thus deepen their capacity to engage in society[2,3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Depends on selected activity

Entrance requirements

Mandatory: Min. 90 ECTS and all modules of first and second semester

Recommended:

Reading list

Depends on selected activity

Examination

Internship: written report

Study abroad: successful completion of 15 ECTC, written report and presentation to supervisor of study abroad

Teaching materials and media

Depends on selected activity

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence		X	
Methodological competence		X	
Social competence		X	

last amended: May 2026

BE 7 4392 Academic Methods and Principles

Study Semester: **7** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Seminar	20 h	Preparation for contact time	40 h
Exercise	30 h	Literature review	60 h
Sum	50 h	Sum	100 h

Total workload: **150 h**

Module coordinator

Prof. Dr. habil. Christoph Böhmer

Lecturers

Prof. Dr. habil. Christoph Böhmer; Dr. Petra Gawalek; Dr. Wael Sabra

Teaching contents

Techniques of scientific work; basics of scientific work; structure of a scientific work; use of a library and scientific literature; literature research: presentation of results and topics; handling specialist literature: excerption; handling and proving arguments; presentation of results; presentation techniques; writing an academic paper

Learning objectives

On successful completion of this module, students should

- know the principles of scientific work and are able to apply and document these in practice[1,3]
- know the general structure of a scientific work and are able to arrange and format it[1,3]
- be able to document scientific issues[3]
- be acquainted with methodical aspects; internalize science-ethical issues like copyright, correct citation, plagiarism, etc.[1,2]
- be able to judge references and sources with respect to their relevance and significance[4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and Judgement

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Mandatory: None

Recommended:

Reading list

Literature will be provided by the lecturer.

Examination in winter term 2026/27

certificate: written exam, 180 minutes

Teaching materials and media

Beamer; white/black board; hand-outs; flipchart; visualisation aids for presentation; AV-Media

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence		X	
Methodological competence	X		
Social competence			X

last amended: May 2026

BE 7 4371 Project reg. Academic Principles and Methods in Preparation of Bachelor Thesis (elective module)

Study Semester: **7** **Credit Points (ECTS):** **10**

Workload

Contact time		Self-study	
Project practice-oriented	30 h	Preparation for contact time	20 h
		Literature review	50 h
		practical, scientific work	180 h
		writing project report	20 h
Sum	30 h	Sum	270 h

Total workload: **300 h**

Module coordinator

Prof. Dr. Joachim Fensterle

Lecturers

all lecturers of the faculty

Teaching contents

The student should be prepared for his or her bachelor thesis through applied research. As a rule, the intended supervisor of the thesis will enable the student to gain theoretical and practical experience by working independently on a scientific topic that is preferably close to the planned thesis. All aspects of scientific work are taken up here, i.e. in addition to practical work (e.g. in the laboratory), in particular literature studies on the content and methodological preparation of the topic, experiment planning, scientifically appropriate documentation and writing of a final report, as well as presentation of the (interim) results in status seminars and oral final presentation if necessary.

The planned workload of 300 hours is to be completed as a rule during a continuous period of 6 weeks after completion of the internship, whereby the contact time and self-study portions can vary depending on the type of research activity. The figures given in the above table are therefore to be understood as a guideline.

The project for the preparation of the Bachelor's thesis can also be carried out in the company of the internship.

Learning objectives

On successful completion of this module, students should

- be able to work independently with scientific literature[3]
- be able to apply methods of theoretical and scientific work[1,3]
- be able to correctly document scientific work[3]
- have deepened their specialist knowledge on specific topics[1,3,4]
- have expanded their ability to work in a team[3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

practical scientific work

Entrance requirements

Mandatory: None

Recommended: Internship or study abroad (SA 6 4991); Academic Methods and Principles (SA 5 4992); relevant basic courses of the semesters 1–5 according to the choice of topic

Reading list

Depending on the chosen subject area, scientific literature is made available by the supervisor or procured by the student.

Examination

certificate: depends on chosen project

Teaching materials and media

Relevant subject-related literature; if applicable, relevant laboratory equipment

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence		X	

last amended: May 2026

BE 550 Language Course for Students (without and with previous knowledge) (elective module)

Study Semester: **1–7 (winter term/summer term)** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Language course	52 h	Preparation for contact time	20 h
		Mandatory Exercises Moodle/ Self study	58 h
		Preparation for exams	20 h
Sum	52 h	Sum	98 h

Total workload: **150 h**

Module coordinator

CIL: Office of Languages and Intercultural Communication

Lecturers

Ratka Sozovska, Corinna Roth and freelance lecturers

Teaching contents

Module contents are based on the “can-do statements” of the Common European Framework of Reference for Languages (CEFR) for the levels A1–B2. All four skills areas – Listening, Speaking, Reading, Writing – are practiced.

Learning objectives

The main objective of these modules is to develop students’ verbal and written communication skills as well as to impart to them effective general learning and communication strategies. Upon successful completion of these modules, students should be able to navigate common everyday situations using linguistic means of communication according to the respective level.

- 1 2 3

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Classroom instruction; mandatory exercises in Moodle; self-study

Entrance requirements

Further information can be found in the “Module Guide for Credit-Bearing Language Courses” on the HSRW homepage.

Reading list

Further information can be found in the “Module Guide for Credit-Bearing Language Courses” on the HSRW homepage.

Examination

certificate: see the module description provided by the International Centre

Teaching materials and media

Beamer; white/black board; hand-outs; visualisation aids for presentation; demonstration material; Webex

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence		X	
Methodological competence			X
Social competence	X		

last amended: May 20256

BE 7 WPF_3 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study Semester: **7** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	60 h	Preparation for contact time	30 h
		Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

All lecturers of the university

Teaching contents

Depending on the chosen module to be elected from any bachelor study course of Rhine-Waal University

Learning objectives

On successful completion of this module, students should

- have acquired knowledge from other areas of the university and deepened or enlarged their horizon[1]
- understand the importance of getting information beyond their specialisation[2]
- be able to implement alternative ways and approaches to problem solving[3]
- be able to compare contents and learning outcomes of other study courses with their own achievements[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Depending on chosen module

Entrance requirements

Depending on chosen module

Reading list

Depending on chosen module

Examination

graded exam: depends on chosen module

Teaching materials and media

Depending on chosen module

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence		X	
Social competence			

last amended: May 2026

BE 7 WPF_4 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study Semester: **7** **Credit Points (ECTS):** **5**

Workload

Contact time		Self-study	
Lecture	60 h	Preparation for contact time	30 h
		Literature review	30 h
		Preparation for exams	30 h
Sum	60 h	Sum	90 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Peter F. W. Simon

Lecturers

All lecturers of the university

Teaching contents

Depending on the chosen module to be elected from any bachelor study course of Rhine-Waal University

Learning objectives

On successful completion of this module, students should

- have acquired knowledge from other areas of the university and deepened or enlarged their horizon[1]
- understand the importance of getting information beyond their specialisation[2]
- be able to implement alternative ways and approaches to problem solving[3]
- be able to compare contents and learning outcomes of other study courses with their own achievements[4]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and judgement

Teaching and learning methods

Depending on chosen module

Entrance requirements

Depending on chosen module

Reading list

Depending on chosen module

Examination

graded exam: depends on chosen module

Teaching materials and media

Depending on chosen module

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence		X	
Social competence			

last amended: May 2026

BE 7 4393 Bachelor Thesis

Study Semester: **7** **Credit Points (ECTS):** **12**

Workload

Contact time	Self-study
Sum	Sum 360 h

Total workload: **360 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

All lecturers of the faculty

Teaching contents

The contents of the bachelor thesis are specific and have to be coordinated with the chosen/elected instructor/lecturer. The assigned task will be adequately described and documented as well as the chosen approach, methodology and results.

Learning objectives

On successful completion of this module, students should

- demonstrate that they are able to complete a praxis-oriented task from their field of study without help and within an allotted period of time[3]
- be able to implement technical knowledge in a scientifically appropriate way[3,4]
- be able to structure the necessary processes and tasks necessary for solving the conceptual formulation, control their progress and adjust if necessary[3]
- be able to document their starting point, the chosen approach and their findings in such a way that they fulfill the requirements of a scientific publication[3]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and Judgement

Teaching and learning methods

None

Entrance requirements

Mandatory: Depending on chosen subject/task; minimum of 180 ECTS

Recommended:

Reading list

Depending on chosen subject/task

Examination

graded exam: written thesis of approx. 40–100 pages

Teaching materials and media

Specific

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			

last amended: May 2026

BE 7 4394 Colloquium

Study Semester: **7** **Credit Points (ECTS):** **3**

Workload

Contact time	Self-study
Sum	Sum 90 h

Total workload: **90 h**

Module coordinator

Prof. Dr. Björn Neu

Lecturers

All lecturers of the faculty

Teaching contents

The content of the colloquium is based on the bachelor thesis.

Learning objectives

The students

- present the results of their bachelor thesis during the colloquium[5]
- put their research and findings in a context with the practical approach and present their findings in a scientific and structured way[1,2,3]
- justify their chosen approach autonomously by taking into consideration how far their results were influenced by assumptions/presuppositions and simplifications[2,3,4]
- are able to analyse questions regarding their thesis and their findings and to answer these within the frame of the technical and non-technical context[3,4,5]

[1]Knowledge; [2]Comprehension; [3]Application; [4]Analysis; [5]Synthesis and Judgement

Teaching and learning methods

None

Entrance requirements

Mandatory: minimum of 207 ECTS

Recommended:

Reading list

Depending on chosen subject/task

Examination

graded exam: presentation and oral exam, max. 45 minutes

Teaching materials and media

Specific

Areas of competence

Area of competence	Core area	Partly relevant	Of minor relevance
Professional competence	X		
Methodological competence	X		
Social competence			X

last amended: May 2026