HOCHSCHULE
RHEIN-WAAL
Rhine-Waal University
of Applied Sciences

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

November 2020

valid for all students enrolled
from WS 2019/20 onwards

The most important details

Duration:	7 semesters full-time, 9 semesters part-time
Location:	Kleve
Qualification:	Bachelor of Arts, B.A.
Course start:	annually in the winter term
Language:	English
Preparatory internship:	Minimum of 8 weeks working full time before the beginning of the 4th semester, longer practical experience in natural sciences, engineering, organisational and/or economical topics, also in the areas of production or medical institutions with reference to biotechnology/bioengineering
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 seminars, exercises and lab courses is mandatory.
This programme is accredited by	PROGRAMM AKKREDITIERT Akkreditierungsrat

Module Nr. /Modul-Nr.	Modules/Module	Module Requirements Modulvoraus-setzungen	CH SWS	Type					Ex/Prü		CP*	SWS / CH							
				L/V	S	E/Ü	LC/Pr	Pro	graded/ benotet	attestation/ Testat		WT / WS 1	ST / SS 2	WT / WS 3	ST / SS 4	WT / WS 5	ST / SS 6	WT / WS 7	
BE_01	Cell Biology and Microbiology Zellbiologie und Mikrobiologie		4	2			2		P	T	5	4							*
BE_02	Fundamentals of Chemistry Grundlagen der Chemie		4	2			2		P	T	5	4							*
BE_03	Bioengineering Physics I Bioengineering Physik I		4	2		1	1		P	T	5	4							*
BE_04	Mathematics Mathematik		6	2	1	3			P		5	6							
BE_05	International Project Management Internationales Projektmanagement		5	1	3	1				T	5	5							
BE_06	Basics of Economic Sciences and Law Grundlagen der Wirtschafts- und Rechtswissenschaften		5	1	3	1			P		5	5							
BE_07	Genetics and Molecular Biology Genetik und Molekularbiologie	BE_01	4	2			2		P	T	5		4						*
BE_08	Applied Chemistry Angewandte Chemie	BE_02	6	2	1	2	1		P	T	5		6						*
BE_09	Biochemistry Biochemie	BE_02	4	2			2		P	T	5		4						*
BE_10	Bioengineering Physics II Bioengineering Physik II	BE_03	4	2		1	1		P	T	5		4						*
BE_11	Applied Microbiology Angewandte Mikrobiologie	BE_01	4	2			2		P	T	5		4						*
BE_12	Applied Mathematics Angewandte Mathematik	BE_04	4	2		2			P		5		4						
BE_13	Physical Chemistry Physikalische Chemie	BE_03 BE_10	4	2		1	1		P	T	5			4					*
BE_14	Instrumental Analytics Instrumentelle Analyse	BE_03	4	2		2			P		5			4					
BE_15	Measurement and Control Engineering Mess- und Regelungstechnik	BE_04	3	2		1			P		5			3					
BE_16	Process Engineering Chemische Verfahrenstechnik	BE_04	6	2		2	2		P	T	5			6					*
BE_17	Current Topics in Biology Aktuelle Themen der Biologie		4		4					T	5			4					
BE_18	Data Analysis and Applied Statistics Datenanalyse und angewandte Statistik		4		2			2	P		5			4					
BE_19	Bioprocess Engineering Bioverfahrenstechnik	BE_11 BE_16	4	2			2		P	T	5				4				*
BE_20	Enzyme Engineering Enzym Engineering	BE_09	4	2	1	1			P		5				4				
BE_21	Project Projekt	BE_05	4					4		T	5				4				
BE_22	Bioinformatics Bioinformatik	BE_04	4	2		2			P		5				4				
BE_23	Elective modules 1 Wahlpflichtkatalog 1		8	4	4				P		10				8				
BE_24	Downstream Processing Produktaufarbeitung	BE_09 BE_19	4	2	2				P		5					4			
BE_25	Industrial Biotechnology Industrielle Biotechnologie	BE_09 BE_11	4	2	2				P		5					4			
BE_26	Integrated Management Systems and Quality Management Integrierte Managementsysteme und Qualitätsmanagement		4	1	2	1			P		5					4			
BE_27	Elective modules 2 Wahlpflichtkatalog 2		12	4	4	4			P		15					12			
BE_28	Internship or study abroad Praxissemester oder Auslandstudiensemester	min. 90 ECTS **								T	30						X		
BE_29	Academic Methods and Principles Wissenschaftliches Arbeiten		4		2	2				T	5							4	
BE_30	Elective Modules 3 Wahlpflichtkatalog 3		8		4			4		T	10							8	
BE_31	Bachelor Thesis Bachelorarbeit	min. 180 ECTS							P		12							X	
BE_32	Colloquium Kolloquium	207 ECTS							P		3							X	
	total credit hours // Semesterwochenstunden		**139**	**49**	**35**	**27**	**18**	**10**				**28**	**26**	**25**	**24**	**24**	**0**	**12**	
												30	**30**	**30**	**30**	**30**	**30**	**30**	
														150			**60**		
											Credit Points				**210**				

		gesamt	1.Sem	2.Sem	3.Sem	4.Sem	5.Sem	6.Sem	7.Sem
SWS		139	28	26	25	24	24	0	12
CP		210	30	30	30	30	30	30	30

Abbreviations: // Abkürzungen

CH = credit hours per week // SWS = Semesterwochenstunden
WS = winter term // Wintersemester
SS = summer term // Sommersemester
Ex/Prü = type of examination // Prüfungsart
CP = credit points (= ECTS-points)
L/V = Lecture // Vorlesung
E/Ü = exercise // Übung
LC/Pr = lab course // Praktikum
Pro = project // Projekt
T = certificate // Testat (unbenotet)
P = examination (marked) // benotete Prüfung

*ECTS will only be credited after completing all parts of the module.
ECTS werden erst nach vollständigem Ableisten aller Modulteile gutgeschrieben.

** 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.
Ergänzend zu den Voraussetzungen der Rahmenprüfungsordnung zur Zulassung zum Praxis- oder Auslandsstudiensemester hat der/die Studierende das erfolgreiche Ableisten sämtlicher Module/Modulprüfungen des 1. Studienjahres des Studiengangs nachzuweisen

	Elective modules 1 Wahlpflichtkatalog 1		CH	Type L/V	S	E/Ü	LC/Pr	Pro	Ex/Prü graded/ benotet	attestation/ Testat	CP*	
BE_23.1	Technical enzymology and Biocatalysis Technische Enzymologie und Biokatalyse		4		4				P		5	
BE_23.2	Agricultural Biotechnology and Biofuels Grüne Biotechnologie und Biotreibstoffe		4		4				P		5	
BE_23.3	Nanobiotechnology Nanobiotechnologie		3	3					P		5	
BE_23.4	Fluid Mechanics and Systems Dynamics Strömungsmechanik und Systemdynamik		4	2			2		P	T	5	*
BE_23.5	Module from any bachelor study course of Faculty of Life Sciences at Rhine-Waal University of Applied Sciences Wahlmöglichkeit Angebot Fakultät Life Sciences Bachelorstudiengänge		4	4					P		5	***
	2 elective modules amount to		**8**								**10**	

	Elective modules 2 Wahlpflichtkatalog 2		CH	Type L/V	S	E/Ü	LC/Pr	Pro	Ex/Prü graded/ benotet	attestation/ Testat	CP*	
BE_27.1	Metabolic Engineering Metabolic Engineering		4		4				P		5	
BE_27.2	Biological Physics Biologische Physik		4	2			2		P	T	5	*
BE_27.3	Environmental Biotechnology and Microalgae Umweltbiotechnologie und Mikroalgen		4		4				P		5	
BE_27.4	Pharmaceutical Biotechnology and Immunology Pharmazeutische Biotechnologie und Immunologie		4	4					P		5	
BE_27.5	Biopolymers Biopolymere		4	2	1		1		P	T	5	*
BE_27.6	Module from any bachelor study course of Faculty of Life Sciences at Rhine-Waal University of Applied Sciences Wahlmöglichkeit Angebot Fakultät Life Sciences Bachelorstudiengänge		4	4					P		5	***
	3 elective modules amount to		**12**								**15**	

	Elective modules 3 Wahlpflichtkatalog 3		SWS	Type L/V	S	E/Ü	LC/Pr	Pro	Ex/Prü graded/ benotet	attestation/ Testat	CP*	
BE_30.1	Project reg. Academic Principles and Methods in preparation of Bachelor Thesis Projekt zum Wissenschaftlichen Arbeit in der Vorbereitung der Bachelorarbeit		8					8		T	10	
BE_30.2	Language Course Sprachkurs		4			4				T	5	***
BE_30.3	Module from catalogue 1 and 2 of study programme Wahlmöglichkeit aus Wahlpflichtkatalog 1 und 2 des Studiengangs		4	4					P		5	
BE_30.4	Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences Wahlmöglichkeit Angebot HRW Bachelorstudiengänge		4	4					P		5	***
	1-2 elective modules amount to		**8**								**10**	

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. / Die Fakultät behält sich das Recht vor, eine Mindestteilnehmerzahl für das Zustandekommen eines Wahlpflichtkurses festzulegen. Die Zulassung zu Pflichtmodulen erfolgt vorbehaltlich freier Kapazitäten. Die Möglichkeit des

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 over the time. / Die Fakultät behält sich vor, das Wahlpflichtangebot im Laufe der Zeit bei neuen Entwicklungen in verschiedenen Feldern der Biotechnologie durch weitere Fächer zu erweitern.

*** 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. / Die konkrete Auswahl aus dem Studienangebot bedarf der Zustimmung des Prüfungsausschussvorsitzenden.

Table of Contents

BE_01 Cell Biology and Microbiology

Study Semester:	**1** (full time) **1** (part time) **1** (cooperative)	**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; growth and metabolism (respiration, fermentation, photosynthesis); 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 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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

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: November 2019

BE_02 Fundamentals of Chemistry

Study Semester:	**1** (full time) **1** (part time) **1** (cooperative)	**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:
atomic structure: atoms, elements and compounds, atomic models; chemical bond: covalent, ionic, metal; definition of the chemical equilibrium; acid and base chemistry: *p*H-values, strong and weak acids and bases, neutralization, calculation of buffer solutions; redox reactions: definition of oxidation und reduction, making-up redox reactions, corrosion processes; electrochemistry: standard reduction potentials, electrolysis, electrolytic cells

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; use of anions in in chemical analysis; redox reaction in aqueous media and in melt; evaluation of corrosion effects with regard to the redox series; complex compounds

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]
- appreciate the importance of chemistry for every day's life[5]
- 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

Entrance requirements

Mandatory: None

Recommended:

Reading list

McMurry und Fay: General Chemistry: Atoms First
Corwin: Introductory Chemistry
Zumdahl: Chemistry: An Atom's First Approach

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course, based on attendance and laboratory reports

Teaching materials and media

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			

last amended: November 2019

BE_03 Bioengineering Physics I

Study Semester:	**1** (full time) **1** (part time) **3** (cooperative)	**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:
Physical quantities and measurements; kinematics; dynamics; motion of particles and rigid bodies; work and energy; temperature; heat and ideal gases; laws of thermodynamics

Lab course:
Kinematics; linear momentum and collisions; harmonic oscillations; resonance; moment of inertia

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

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: November 2019

BE_04 Mathematics

Study Semester:	**1** (full time) **1** (part time) **1** (cooperative)	**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 integra)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Lab reports (testate)

Teaching materials and media

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: November 2019

BE_05 International Project Management

Study Semester:	**1** (full time) **3** (part time) **3** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture	15 h	Preparation for contact time	35 h
Seminar	45 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. Joachim Fensterle

Lecturers

Lesley Lap; Anette Sickert Karam; 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]
- 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

Certificate according to §§ 14 and 20 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_06 Basics of Economic Sciences and Law

Study Semester:	**1** (full time) **5** (part time) **3** (cooperative)	**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

N.N.

Lecturers

Andreas Frerichs

Teaching contents

Business Administration: basics of business administration: production factors, management functions, economic principles, workflow and structure organization; cost accounting: terms of accounting: disbursement, expenditure, expense, costs and analogously receipt of payment, revenue, income, benefits; non-operating expense, expenses for costing purposes; introduction in accountancy: balance of accounts, income statement, simple accounting record; bill of charges: variable (proportional, progressive, degressive, regressive) and fixed costs (step costs), costs of goods manufactured, acquisition price; cost categories, cost units and cost object accounting; accounting for actual costs, normal costing, planned cost accounting (basic cases of output costing, equivalent unit calculation, overhead calculation, calculation of joint products, high-low points method); contribution accounting; basics of marketing

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

- know the general management functions[1-4]
- know the basics of workflow and structure organization[1-3]
- be able to interpret basic balances[1-3]
- know the die basal methods of cost accounting[1-4]
- be able to solve costs into determinants[1-4]
- know basic market mechanisms[1-3]

- know the differences between rather market-based and monopolistic action[1-2]
- be able to integrate marketing in the context of managerial processes[1]
- understand marketing as managing tool and differ marketing from classical advertising[2]
- know the basics of liability according to civil law which result from neglecting legal provisions[1]
- have insight in structure and principles of the civil code[1]
- be able to read and to interpret legislative texts and contracts[2,4]
- understand the importance of patents and inventions as property rights and for innovations and innovation management[1,2]
- know the basics of the genetic engineering law and provisions when working with genetic modified organisms (GMO)[1,2,3]
- be able to consider the social and legal 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:

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
Pride, Hughes and Kapoor: Introduction to Business
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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: October 2020

BE_07 Genetics and Molecular Biology

Study Semester:	**2** (full time) **2** (part time) **2** (cooperative)	**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; RNA interference; RNA isolation; cDNA synthesis; 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: Cell Biology and Microbiology (BE_01)

Recommended: Fundamentals of Chemistry (BE_02)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

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: November 2019

BE_08 Applied Chemistry

Study Semester:	**2** (full time) **4** (part time) **4** (cooperative)	**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	30 h	Preparation for exams	30 h
Lab course	15 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:
hydrogen, oxygen and water; chemistry of main group and of transition elements; metals: occurrence, production; metal complexes; radioactivity; functional groups: hydrocarbons with single-, double-, and triple-bonds; aromatic compounds; organohalides; alcohols, phenols and thiols; ethers and epoxides; aldehydes and ketones; carboxylic acids and their derivatives; reactions and mechanisms: radical, nucleophilic and electrophilic substitution; eliminations; additions to C-C-multiple bonds; oxidation and reduction; reactions of carbonyl compounds

Lab course:
purification of educts and products by distillation, filtration, recrystallization; basic substance identification by melting point, boiling point, refractive index; basic synthesis procedures: nucleophilic and electrophilic substitution reactions, elimination reactions, addition reactions

Learning objectives

On successful completion of this module, students should

Organic Chemistry:

- know the basic concepts and terms of organic chemistry[1]
- be able to sketch basic organic reaction mechanisms[3]
- be able to appreciate the influence of organic compounds in every day's life[5]
- be able to plan and conduct organic syntheses in laboratory scale[1]

Inorganic Chemistry:

- know the basic chemistry of the elements and their compounds[1]
- be able to appreciate general trends within the various groups in the periodic table[2]

- be able to point out applications of inorganic compounds and materials – especially in the biomedical area[4]
- be able to assess the risk of inorganic compounds[5]
- be able to explain the role of inorganic compounds in biochemical processes[2]

[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: Fundamentals of Chemistry (BE_02)

Recommended: None

Reading list

McMurry: Organic Chemistry
Hadad, Craine, Hart and Hart: Organic Chemistry
McMurry and Fay: General Chemistry: Atoms First
Lawrance: Introduction to Coordination Chemistry
Mathey and Sevin: Molecular Chemistry of the Transition Elements: An Introductory Course

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course, based on attendance and laboratory reports

Teaching materials and media

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: November 2019

BE_09 Biochemistry

Study Semester:	**2** (full time) **2** (part time) **2** (cooperative)	**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: Fundamentals of Chemistry (BE_02)

Recommended: Cell Biology and Microbiology (BE_01)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

Projector; 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: November 2019

BE_10 Bioengineering Physics II

Study Semester:	**2** (full time) **2** (part time) **4** (cooperative)	**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:
Electricity and magnetism; waves; special theory of relativity; quantum theory; quantum mechanics of atoms; principles of nuclear and medical physics;

Lab course:
geometric optics ; charge over mass ratio; wave optics; thermal radiation; sound waves

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: Bioengineering Physics I (BE_03)

Recommended: None

Reading list

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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes, certificate for lab course

Teaching materials and media

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: November 2019

BE_11 Applied Microbiology

Study Semester:	**2** (full time) **4** (part time) **4** (cooperative)	**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, 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: Cell Biology and Microbiology (BE_01)

Recommended:

Reading list

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

graded lab protocols

Teaching materials and media

Projector; white/black board; hand-outs; overhead projector; flipchart; visualisation aids for presentation; demonstration material; flipped-classroom elements with self assessments

Areas of competence

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

last amended: November 2019

BE_12 Applied Mathematics

Study Semester:	**2** (full time) **2** (part time) **2** (cooperative)	**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, first and second order linear 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_04)

Reading list

Stewart: Calculus – Early Transcendentals. Metric International Version
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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_13 Physical Chemistry

Study Semester:	**3** (full time) **3** (part time) **5** (cooperative)	**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:
Laws of Thermodynamics; phase equilibria; chemical equilibrium; kinetics; rates of reactions; biomolecular structure; macromolecules and self-assembly

Lab course:
ideal gas law; kinetics; boiling point elevation; boiling diagram, enthalpy

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: Bioengineering Physics I (BE_03); Bioengineering Physics II (BE_10)

Recommended:

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

Projector; 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: November 2019

BE_14 Instrumental Analytics

Study Semester:	**3** (full time) **5** (part time) **5** (cooperative)	**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); electroanalytical methods: amperometry, polarography, voltammetry, potentiometry, coulometry

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: Basics of Physics (BE_03)

Recommended: Fundamentals of Chemistry (BE_02); Applied Chemistry (BE_08)

Reading list

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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: October 2020

BE_15 Measurement and Control Engineering

Study Semester:	**3** (full time) **3** (part time) **5** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	30 h
Exercise	15 h	Literature review	30 h
		Preparation for exams	45 h
Sum	45 h	Sum	105 h

Total workload: **150 h**

Module coordinator

Prof. Dr.-Ing. Frank Platte

Lecturers

Prof. Dr.-Ing. Frank Platte

Teaching contents

tasks, 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

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[3,4,5]
- 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: Mathematics (BE_04)

Recommended: Basics of Physics (BE_03), Applied Mathematics (BE_12)

Reading list

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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_16 Process Engineering

Study Semester:	**3** (full time) **3** (part time) **5** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture	30 h	Preparation for contact time	15 h
Exercise	30 h	Literature review	10 h
Lab course	30 h	Preparation for exams	35 h
Sum	90 h	Sum	60 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), 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

Lab course:
saponification in a BR, CSTR and PFR; measurements of residence time distribution (RTD) and dispersion effects; Bernoulli experiment; Osbourne-Reynolds experiment; analysis and synthesis of control loops using Matlab/Simulink; temperature control in a wind tunnel using Microcontroller (e.g. ARDUINO) and Simulink; water level control; foam and concentration control in fermenters

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: Mathematics (BE_04)

Recommended: Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03), Applied Mathematics (BE_12)

Reading list

Fogler and Scott: Elements of Chemical Reaction Engineering
Levenspiel and Octave: Chemical Reaction Engineering
Potter, Wiggert and Ramadan: Mechanics of Fluids

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

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: November 2019

BE_17 Current Topics in Biology

Study Semester:	**3** (full time) **7** (part time) **5** (cooperative)	**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

Prof. Dr. Joachim Fensterle

Teaching contents

The current state of the art in research will be presented by researchers of different fields of bioengineering. Companies and institutions involved in state of the art biotechnological research will be visited. Students will analyse and interpret original research works in each field.

Students will form project groups, where they work out a new research concept including budgeting and funding possibilities in a selected field. Students will present the concept in oral and written form.

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 scientific report and a presentation[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

Original papers and reviews

Examination

Certificate according to §§ 14 and 20 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: October 2020

BE_18 Data Analysis and Applied Statistics

Study Semester:	**3** (full time) **5** (part time) **5** (cooperative)	**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

Data Analysis: statistics in the analysis of biological data; computer-assisted (CA) analysis of large data sets, CA of spectral data, AI for data analysis

Applied Statistics: Probability theory, random variables, probability distributions; Inferential statistics; correlation, hypothesis testing; univariate, multivariate regression analysis; analysis of variance, post hoc test; parameter estimation, 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_04)

Reading list

Stewart: Calculus – Early Transcendentals. Metric International Version
Strang: Linear Algebra and 1st Applications (see http://www.mit.edu -> OpenCourseWare)
Stewart: Calculus, Metrics
Strang: Linear Algebra and 1st Applications (see http://www.mit.edu -> OpenCourseWare)
Bulmer: Principles of Statistics
Field: Discovering Statistics using R, Sage
Delore: Statistics for Scientists and Engineers, Pearson
Veaux: Stats: Data and Models
Attaway: MATLAB – A Practical Introduction to Programming and Problem Solving
Moler: Numerical Computing with MATLAB (http://www.mathworks.de/moler/index_ncm.html)

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Graded project report;

Teaching materials and media

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: October 2020

BE_19 Bioprocess Engineering

Study Semester:	**4** (full time) **4** (part time) **6** (cooperative)	**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: Applied Microbiology (BE_11), Process Engineering (BE_16)

Recommended: Applied Mathematics (BE_12)

Reading list

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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

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: November 2019

BE_20 Enzyme Engineering

Study Semester:	**4** (full time) **4** (part time) **6** (cooperative)	**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: Biochemistry (BE_09)

Recommended: Genetics and Molecular Biology (BE_07); Instrumental Analytics (BE_14)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_21 Project

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**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

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: International Project Management (BE_05)

Recommended: 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

Certificate according to §§ 14 and 20 General Examination Regulations for Bachelor’s and Master’s Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_22 Bioinformatics

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**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

N.N.

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: Mathematics (BE_04)

Recommended: Data Analysis and Applied Statistics (BE_18)

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: 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
Matlab primer: https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf
Polya: How to solve it: A New Aspect of Mathematical Method

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_23.1 Technical Enzymology and Biocatalysis

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**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-catalyzed 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_08); Biochemistry (BE_09); Enzyme Engineering (BE_20)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_23.2 Agricultural Biotechnology and Biofuels

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Seminar/Project	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. Joachim Fensterle

Lecturers

Prof. Dr. Joachim Fensterle; 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, transesterification, Biomass-to-Liquid (BTL) conversion, methanol, DME, DMC synthesis, solid biomass, combustion, carbonisation and gasification of biomass, anaerobic fermentation, production costs, 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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_23.3 Nanobiotechnology

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture/Seminar	45 h	Preparation for contact time	30 h
		Literature review	45 h
		Preparation for exams	30 h
Sum	45 h	Sum	105 h

Total workload: **150 h**

Module coordinator

Prof. Dr. Kerstin Koch

Lecturers

Prof. Dr. Kerstin Koch

Teaching contents

The lecture/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; 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 economy; energy use and production; nanotechnology and water; nanotechnology and the environment; funding, research and future perspectives.

Learning objectives

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[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

Lecture; self-study; group work and student presentations

Entrance requirements

Mandatory: None

Recommended: Cell Biology and Microbiology (BE_01); Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Graded presentation and graded written exam

Teaching materials and media

Projector; 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: November 2019

BE_23.4 Fluid Mechanics and Systems Dynamics

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture, Exercise	30 h	Preparation for contact time	30 h
Practical training	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.-Ing. Sylvia Moenickes

Lecturers

Prof. Dr.-Ing. Frank Platte; Prof. 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: linear and higher order models, compartment schemes, superposition; steady states and stability of systems, sensitivity; models in time and space

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: Bioengineering Physics I (BE_03); Mathematics and Statistics (BE_04); Applied Mathematics (BE_12)

Reading list

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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Lab reports (testate)

Teaching materials and media

Projector; 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: November 2019

BE_23.5 Module from any Bachelor Study Course at Faculty of Life Sciences at Rhine-Waal University of Applied Sciences

Study Semester:	**4** (full time) **6** (part time) **6** (cooperative)	**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 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 according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019

BE_24 Downstream Processing

Study Semester:	**5** (full time) **5** (part time) **7** (cooperative)	**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; Stefan Klein

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: Biochemistry (BE_09); Bioprocess Engineering (BE_19)

Recommended:

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

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_25 Industrial Biotechnology

Study Semester:	**5** (full time) **7** (part time) **7** (cooperative)	**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

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: Biochemistry (BE_09); Applied Microbiology (BE_11)

Recommended:

Reading list

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

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: November 2019

BE_26 Integrated Management Systems and Quality Management

Study Semester:	**5** (full time) **7** (part time) **7** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture	15 h	Preparation for contact time	45 h
Seminar	30 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.-Ing. Rudolf Schumachers

Lecturers

Dr: Bernd Kimpfel

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, OHSAS 18001, ISO 19011, ISO 26000); 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 agricultural contexts (e.g. GLOBALGAP, EC 834/2007, NOP); 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 sustainability 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, 31000
Guidelines on Occupational Safety and Health Management Systems, ILO-OSH 2001; OHSAS 18001
Jackson: The ISO 14001 Implementation Guide
Zink: Total Quality Management as a Holistic Management Concept
Goetsch: Quality Management for Organizational Excellence: Introduction to Total Quality
Forster: Practical Management Handbook

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_27.1 Metabolic Engineering

Study Semester:	**5** (full time) **7** or **9** (part time) **7** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Seminar/Project	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

Dr. Georg Lentzen

Teaching contents

Basic principles of metabolic engineering; regulation of metabolic pathways; modeling 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_09); Applied Microbiology (BE_11); Enzyme Engineering (BE_20)

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

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_27.2 Biological Physics

Study Semester:	**5** (full time) **7** or **9** (part time) **7** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture/Seminar	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

Teaching contents

Lecture/Seminar: This course introduces the methods of physics and physical chemistry to study biological systems. Specific topics include: model building in biology; cell physiology; macromolecular assemblies and devices; thermal motion; diffusion law; biological applications of the diffusion law; friction in fluids; self assembly of amphiphiles, molecular devices found in cells; mechanochemcial motors; kinetics of molecular machines; machines in membranes

Lab Course: This part of the course introduces topics and applications in the area of biological/medical physics such as optical tweezers, cellular mechanical properties, medical imaging, impedance spectroscopy and electroencephalography.

Learning objectives

On successful completion of this module, students should

- understand the basic theories and methods in biological physics[1,2]
- be able to analyze 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: BE_13 Physical Chemistry

Reading list

Nelson and Freeman: Biological Physics
Phillips: Physical Biology of the Cell

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

Projector; 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: November 2019

BE_27.3 Environmental Biotechnology and Microalgae

Study Semester:	**5** (full time) **7** or **9** (part time) **7** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Seminar/Project	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. Joachim Fensterle

Lecturers

Prof. Dr. habil. Waltraud Kofer

Teaching contents

Environmental Biotechnology: microbial biodegradation, microbial bioaugmentation, biofuels, biogas, environmental (microbiological) bioprocessing, sustainable biotechnology, green process development. Selected environmental biotechnology approaches (e.g. biodegradation of persistent pesticides in soil, biosorption of metals, optimization of biogas production, bioconversion of lignin)

Microalgae: Prokaryotic and eukaryotic cells; Taxonomy of algae; Anatomy and physiology of algae; Growth forms and control of algal growth; Algae and the environment; Algae as bioindicators; Sampling, biomass estimation and counts of freshwater algae; Microalgae biomass production and harvesting; Microalgae as a feedstock for biofuels

Learning objectives

On successful completion of this module, students should

Environmental Biotechnology

- know the principles of microbiological environmental processes[1]
- be able to name examples[1]
- be able to develop and present a selected environmental biotechnology approach[3,4,5]

Microalgae

- have been introduced to the diversity of algae and have gained basic knowledge in anatomy, physiology, and growth patterns of algae[1]
- comprehend the ecological importance of algae in different ecosystems and how the algae's sensitivity qualifies them as bioindicators[1,2,3]
- have been introduced to the fundamentals of biological process engineering and monitoring and thus will be able to understand the technical background to the use of microalgae cultivation for the production of biofuel[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: Applied microbiology (BE_11)

Reading list

Satyanarayana: Microorganisms in Sustainable Agriculture and Biotechnology
Benkeblia: Sustainable Agriculture and New Biotechnologies
OECD: The Application of Biotechnology to Industrial Sustainability
Antranikian: Angewandte Mikrobiologie
Lee: Phycology
Bellinger and Sigee: Freshwater algae: identification and use as bioindicators
Gouveia: Microalgae as a Feedstock for Biofuels

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_27.4 Pharmaceutical Biotechnology and Immunology

Study Semester:	**5** (full time) **7** or **9** (part time) **7** (cooperative)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture/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. 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 U;. 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, tumorimmunology, autoimmunity, immunodeficiencies

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_09), Applied Microbiology (BE_11), Bioprocess Engineering (BE_19)

Reading list

Kayser: Pharmaceutical Biotechnology – Drug Discovery and Clinical Applications
Walsh: Pharmaceutical Biotechnology – Concepts and Applications.

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_27.5 Biopolymers

Study Semester:	**5** (full time) **7** or **9** (part time) **7** (cooperative)	**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:
detailed knowledge of the structure, function, properties, and use of biopolymers; distribution functions; molecular structure of typical biological materials such as starch and rubber as well as synthetic material such as poly lactic acid; mechanical and thermal properties of biopolymers and their analysis; thermodynamics in solution of biopolymers with a special focus on the determination of the molar mass distribution; degradation of biopolymers; comparison of the environmental impact of biopolymers and synthetic polymers.

Lab Course:
synthesis of model polymers by step growth and chain growth mechanism; coagulation and properties of natural rubber; identification polymer material

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 identify specific biopolymers to biological structures in nature[2,3]
- 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 and presentation

Entrance requirements

Mandatory: None

Recommended: Fundamentals of Chemistry (BE_02); Bioengineering Physics I (BE_03); BE_04 Mathematics (BE_04); Applied Chemistry (BE_08); Physical Chemistry (BE_13); Instrumental Analytics (BE_14)

Reading list

Hiemenz and Lodge: Polymer Chemistry
Smidsrod: Biopolymer Chemistry
Plackett (Ed.): Biopolymers, New Materials for Sustainable Films and Coatings
Fakirov and Bhattacharyya: Engineering Biopolymers
Kalia and Avérous: Biopolymers: Biomedical and Environmental Applications

Examination

Graded exam according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes; certificate for lab course

Teaching materials and media

Projector; 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: November 2019

BE_27.6 Module from any Bachelor Study Course at Faculty of Life Science at Rhine-Waal University of Applied Sciences

Study Semester:	**5** (full time) **7** or **9** (part time) **7** (cooperative)	**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 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 according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019

BE_28 Internship or Study Abroad

Study Semester:	**6** (full time) **1–7** (part time) **8** (cooperative)	**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: Intention of the work placement is for the students to work in one or more functional divisions/branches of a company in order to implement knowledge and methods from their studies. The students are requested to consider the coherencies of economic, social and environmental aspects. After finishing the internship, the experience gained during the practical semester must be summarized in a written report according to criteria defined beforehand by the student and the supervising professor. The work placement can also be pursued abroad.

Study abroad: Instead of the work placement the students have the option to study a semester at a university abroad in order to deepen their theoretical and practical knowledge. The students attend 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. 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.

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.

[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

Certificate according to §§ 14 and 20 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019

BE_29 Academic Methods and Principles

Study Semester:	**7** (full time) **9** (part time) **9** (cooperative)	**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. Björn Neu

Lecturers

N.N.

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

Certificate according to §§ 14 and 20 General Examination Regulations for Bachelor's and Master's Degree Programmes

Teaching materials and media

Projector; 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: November 2019

BE_30.1 Project reg. Academic Principles and Methods in Preparation of Bachelor Thesis

Study Semester:	**7** (full time) **9** (part time) **9** (cooperative)	**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 in his/her own research environment 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 (BE_28); Academic Methods and Principles (BE_29); 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 according to §§ 14 and 20 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019

BE_30.2 Language Course for Students (Without Previous Knowledge)

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

Workload

Contact time		Self-study	
Language course	52 h	Preparation for contact time	28 h
		Self study	50 h
		Preparation for exams	20 h
Sum	52 h	Sum	98 h

Total workload: **150 h**

Module coordinator

International Center: Office of Languages and Intercultural Communication

Lecturers

Ratka Sosovska; Frau Elfriede van Dijk (LfbA DaF)

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 this module is to develop students’ verbal communication skills as well as to impart to them effective general learning and communication strategies. Upon successful completion of this module, students should be able to navigate common everyday situations using simple linguistic means of communication.

On successful completion of this module, students should

- Xxx[hochgestellte Zahl]

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

Teaching and learning methods

classroom instruction; language practice in Language Lab; self-study

Entrance requirements

Level A1.1: The main objective of this module is to develop students’ verbal communication skills in German as well as to impart to them effective general learning and communication strategies. Upon successful completion of this module, students should be able to navigate common everyday situations using simple linguistic means of communication.

Level A1.2: The main objective of this module is the continued development of students' verbal communication skills by expanding their passive and active vocabularies and solidifying their grasp on underlying grammatical structures. Upon successful completion of this module, students should be able to navigate common everyday situations using simple linguistic means of communication.

Level A2.1: The main objective of this module is the continued development of students' communicative skills by expanding and solidifying their passive and active vocabularies, as well as their understanding and use of more advanced grammatical structures. Upon successful completion of this module, students should be able to navigate many everyday situations using limited means of communication, as well as produce and understand commonly used terms and phrases in German. Continued practice of learning strategies is also a central component of this module.

Level A2.2: The main objective of this module is the continued development of students' communicative skills by expanding and solidifying their passive and active vocabularies, as well as their understanding and use of advanced grammatical structures. Upon successful completion of this module, students should be able to navigate many everyday situations using limited means of communication, as well as produce and understand commonly used terms and phrases in German. Continued practice of learning strategies is also a central component of this module.

Level B1.1: The main objective of this module is the development of applied language skills so that students can communicate effectively in German both on and off campus. Developing effective writing skills receives more focus at the B1 level as well. Upon successful completion of this module, students should be able to give short presentations on specific (intercultural) topics and answer related questions from the audience.

Reading list

Studio [21] Das Deutschbuch A1-B1/+Medienpaket
Studio d Die Mittelstufe (B2/1 oder B2/2)

Examination

Certificate according to §§ 14 and 20 General Examination Regulations for Bachelor's and Master's Degree Programmes

A recognised certificate obtained elsewhere, confirming level B1.2 or higher, may be recognised.

Teaching materials and media

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 2019

BE_30.3 Module from Catalogue Elective Modules 1 and 2 of Study Course Bioengineering

Study Semester:	**7** (full time) **9** (part time) **8** (cooperative)	**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 study course

Teaching contents

Depending on the chosen module to be elected from catalogues Elective Modules 1 and 2 of Bioengineering

Learning objectives

On successful completion of this module, students should

- have broadened their knowledge of the chosen focus fields[1]
- understand the importance of broadening their knowledge beyond their specialisation[2]
- be able to implement alternative ways and approaches to problem solving[3]
- be able to compare contents and learning outcomes 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 according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019

BE_30.4 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study Semester:	**7** (full time) **9** (part time) **8** (cooperative)	**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 according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019

BE_31 Bachelor Thesis

Study Semester:	**7** (full time) **8** (part time) **9** (cooperative)	**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 according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes and § 7 Examination Regulations for study programme: 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: November 2019

BE_32 Colloquium

Study Semester:	**7** (full time) **9** (part time) **9** (cooperative)	**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 analyze 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 according to §§ 14, 17–19 General Examination Regulations for Bachelor's and Master's Degree Programmes

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: November 2019