HOCHSCHULE
RHEIN-WAAL
Rhine-Waal University
of Applied Sciences

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

October 2018

Version October 2018

The most important details

Duration:	7 semesters full-time, 9 semesters part-time
Location:	Kleve
Qualification:	Bachelor of Science, B.Sc.
Course Start:	Annually in the winter term
Language:	English
Practical Course:	Minimum of 8 weeks 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 8th semester (part time) in the 9th semester (cooperative)
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.

This study programme is an

Curriculum Bachelorstudiengang Bioengineering

Modul-Nr./ Module No.	Module/Subjects	SWS CH	Type					Ex/Prü	CP	SWS / CH						
			L/V	S	E/Ü	LC/Pr	Pro			WS / WT 1	SS / ST 2	WS / WT 3	SS / ST 4	WS / WT 5	SS / ST 6	WS / WT 7
BE_01	Cell Biology and Microbiology Zellbiologie und Mikrobiologie	4	2			2		P	5	4					BE_28, Internship or study abroad / Praxissemester oder Auslandstudiensemester (30 CP)	BE_31 Colloquium / Kolloquium (8 CP)
BE_02	Fundamentals of Chemistry Grundlagen der Chemie	4	2			2		P	5	4						
BE_03	Basics of Physics Grundlagen Physik	4	2		1	1		P	5	4						
BE_04	Mathematics and Statistics Mathematik und Statistik	6	3		3			P	5	6						
BE_05	Basics of Management Managementgrundlagen	4	2		2			T	5	4						
BE_06	Project 1 Projekt 1, Wiss. Arbeiten	4					4	T	6	4						
BE_07	Genetics and Molecular Biology Genetik und Molekularbiologie	4	2			2		P	5		4					
BE_08	Applied Chemistry Angewandte Chemie	6	3		2	1		P	5		6					
BE_09	Biochemistry Biochemie	4	2			2		P	5		4					
BE_10	Bioengineering Physics Bioengineering Physik	4	2		1	1		P	5		4					
BE_11	Applied Microbiology Angewandte Mikrobiologie	4	2			2		P	5		4					
BE_12	Applied Mathematics Angewandte Mathematik	4	2		2			P	5		4					BE_30 Bachelor Thesis / Bachelorarbeit (12 CP)
BE_13	Physical Chemistry Physikalische Chemie	4	2		1	1		P	5			4				
BE_14	Instrumental Analytics Instrumentelle Analyse	4	2		2			P	5			4				
BE_15	Measurement and Control Engineering Mess- und Regelungstechnik	4	2		1	1		P	5			4				
BE_16	Process Engineering Chemische Verfahrenstechnik	5	3		2			P	5			5				
BE_17	Basics of Economic Sciences Grundlagen der Wirtschaftswissenschaften	5	4		1			P	5			5				
BE_18	Applied Management Angewandtes Management	4	2		2			T	5			4				
BE_19	Bioprocess Engineering Bioverfahrenstechnik	4	2			2		P	5				4			
BE_20	Enzyme Engineering Enzym Engineering	4	4					P	5				4			
BE_21	Project 2 Projekt 2	4					4	T	10				4			
BE_22	Downstream Processing Produktaufarbeitung	4	2	2				P	5					4		BE_29 Workshop (5 CP)
BE_23	Industrial Biotechnology Industrielle Biotechnologie	4	4					P	5					4		
BE_24	Basics of Law Grundlagen Rechtswissenschaft	4	2		2			P	5					4		
BE_25	Integrated Management Systems and Quality Management Integrierte Managementsysteme und Qualitätsmanagement	4	4					P	5					4		
BE_26	Elective modules 1 Wahlpflichtkatalog 1	8	8					P	12				8			
BE_27	Elective modules 2 Wahlpflichtkatalog 2	8	8					P	12					8		
	Semesterwochenstunden // total credit hours	122	73	2	22	17	8			26	26	26	20	24		
										31	30	30	32	32	30	25
									Credit Points	155					55	
										210						

	gesamt	1.Sem	2.Sem	3.Sem	4.Sem	5.Sem	6.Sem	7.Sem
SWS	122	26	26	26	20	24		
CP	210	31	30	30	32	32	30	25

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

Modul-Nr./ Module No.	Elective modules 1 Wahlpflichtkatalog 1	CH	CP	Ex
BE_26.1	Technical enzymology Technische Enzymologie	2	3	P
BE_26.2	Biofuels Biotreibstoffe	2	3	P
BE_26.3	Agricultural Biotechnology Grüne Biotechnologie	2	3	P
BE_26.4	Cellular Biophysics Zelluläre Biophysik	2	3	P
BE_26.5	Medical Bioengineering Medizinische Biotechnologie	2	3	P
BE_26.6	Nanobiotechnology Nanobiotechnologie	2	3	P
BE_26.7	Modeling of Dynamic Systems Modellierung dynamischer Systeme	2	3	P
BE_26.8	Module from any bachelor study course URW Wahlmöglichkeit Bachelor Angebot HRW	2	3	P
BE_26.9	Module from any bachelor study course URW Wahlmöglichkeit Bachelor Angebot HRW	2	3	P
		8	12	

Modul-Nr./ Module No.	Elective modules 2 Wahlpflichtkatalog 2	CH	CP	Ex
BE_27.1	Biocatalysis Biokatalyse	2	3	P
BE_27.2	Metabolic Engineering Metabolic Engineering	2	3	P
BE_27.3	Biopolymers Biopolymere	2	3	P
BE_27.4	Environmental Biotechnology Umweltbiotechnologie	2	3	P
BE_27.5	Microalgae Mikroalgen	2	3	P
BE_27.6	Immunology Immunologie	2	3	P
BE_27.7	Module from any bachelor study course URW Wahlmöglichkeit Bachelor Angebot HRW	2	3	P
BE_27.8	Module from any bachelor study course URW Wahlmöglichkeit Bachelor Angebot HRW	2	3	P
		8	12	

Qualifizierungsbereiche

White (industrial) Biotechnology

Green (agricultural) Biotechnology

Red (medical) Biotechnology

Wahlpflichtkatalog aus anderen Studiengängen

Inhaltsverzeichnis

BE_01 Cell Biology and Microbiology

Study semester:	**1** (full time) **3** (cooperative) **1** (part time)	**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**

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

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

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; 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; direct fluorescent labelling of organelles
Microbiology: basic techniques in microbiology; 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

Intended learning outcomes

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]
- 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]
- 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

None

Reading list

Alberts: Molecular Biology of the Cell
Brock: Biology of Microorganisms

Examination

Graded exam

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 2016

BE_02 Fundamentals of Chemistry

Study semester:	**1** (full time) **1** (cooperative) **1** (part time)	**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**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

Prof. Dr. Peter F. W. Simon

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; practical relevance of the atom's structure theory in chemical analysis; 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

Intended learning outcomes

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 the every day's life[5]
- 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

None

Reading list

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

Examination

Graded exam; oral discussion; laboratory 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 January 2015

BE_03 Basics of Physics

Study semester:	**1** (full time) **1** (cooperative) **1** (part time)	**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**

Coordinator

Prof. Dr. Björn Neu

Instructors

Prof. Dr. Björn Neu

Contents

Lecture/Exercises:
physical quantities and vectors; motion of particles and rigid bodies; work and energy; temperature; heat and ideal gases; laws of thermodynamics

Lab course:
Kinematics; harmonic oscillations; resonance; moment of inertia

Intended learning outcomes

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

None

Reading list

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

Examination

Graded exam

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 January 2015

BE_04 Mathematics and Statistics

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Instructors

Prof. Dr. Sylvia Moenickes; Dr. Peter Henselder; Christoph Knoblauch, M.Sc.

Contents

Introductory Mathematics: Numbers, esp. irrational numbers and their difficulty when using calculator or computer; Heron's method as an example of iterative algorithms, desired accuracy, complex numbers in Cartesian and polar presentation, complex radicals, main theorem of algebra; Linear systems of equations, esp. Gaussian elimination; Vector analysis, esp. linear combinations, scalar and vector product, straight lines and planes in space; Limiting values, esp. definition, central limiting value theorem, steadiness, bisection method; Differential calculus, esp. definition of derivation, derivation rules, tangent, Newton's method, monotony and curvature; Integral calculus, esp. inversion of differentiation – indefinite integral, calculation of area - definite Integral, main theorem of differential and integral calculus

Statistics: probability theory, esp. random variables, probability distributions; descriptive statistics; parameter estimation, hypothesis testing; regression analysis; time series

Intended learning outcomes

Introductory Mathematics:

On successful completion of this module, students should

- know basic mathematical concepts and procedures, in particular differential calculus and its application[1,2,3]
- 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]

Statistics:

On successful completion of this module, students should

- understand[1] and provide[3] quantitative and visual summaries on data sets
- identify[2] underlying probability distributions
- judge determinations, correlations and information through regression analyses[2,3]
- estimate parameters[3] and test hypotheses[3]
- analyse time series[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

None

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, 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 October 2016

BE_05 International Project Management

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Lesley Lap; Annette Sickert Karam

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

Intended learning outcomes

On successful completion of this module, students should

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

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)
Hofstede, Hofstede and Minkow: Cultures and Organizations - Software of the Mind: Intercultural Cooperation and Its Importance for Survival
Trompenaars: Riding the Waves of Culture: Understanding Cultural Diversity in Business

Examination

Presentation; project work; written test

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 2018

BE_06 Project 1

Study semester:	**1** (full time) **3** (cooperative) **5** (part time)	**Credit Points (ECTS):**	**6**

Workload

Contact time		Self-study	
Project	60 h	Preparation for contact time	70 h
		Literature review	30 h
		Preparation for exams	20 h
Sum	60 h	Sum	120 h

Total workload: **180 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Dr. Peter Schiener

Contents

Execution of projects as part of knowledge-based education; structuring of work packages; acquisition and evaluation of scientific literature; development of social competence and ability to work in a team; writing scientific reports; appropriate presentation of results

Intended learning outcomes

On successful completion of this module, students should

- be able to define different project phases based on a given issue[1]
- be able to search scientific literature independently[1, 2]
- be able to organise and manage a project and group work[2]
- develop a mode to evaluate and document scientific results[3]
- summarize and explain the results and findings in a scientific report and a presentation[4]
- be able to critically discuss their findings[5]

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

Teaching and learning methods

Group work; project work; self-study; feedback

Entrance requirements

None

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
Pittampalli: 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 issue various case studies and scientific publications provided by instructor

Examination

Scientific report; presentation

Teaching materials and media

Projector; white/black board; hand-outs; flipchart; visualisation aids for presentation; AV-Media; 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 October 2016

BE_07 Genetics and Molecular Biology

Study semester:	**2** (full time) **4** (cooperative) **2** (part time)	**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**

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

Prof. Dr. habil. Mònica Palmada Fenés

Contents

Lecture:
basics of general genetics and molecular biology: history, structure of DNA, recombination, genetic code, replication, transcription, mRNA processing, translation; genetic engineering: plasmids, recombinant DNA, PCR, cloning, transformation, transduction, transfection, conjugation; 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)

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

Intended learning outcomes

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]

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

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Cell Biology and Microbiology (BE_01)

Reading list

Watson, Baker, Bell, Gann: Molecular Biology of the Gene
Clark: Molecular Biology
Klug, Cummings, 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

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 April 2017

BE_08 Applied Chemistry

Study semester:	**2** (full time) **4** (cooperative) **4** (part time)	**Credit Points (ECTS):**	**5**

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

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

Contents

Lecture:
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

Intended learning outcomes

Organic Chemistry:

On successful completion of this module, students should

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

Inorganic Chemistry:

On successful completion of this module, students should

- 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

Fundamentals of Chemistry (BE_02)

Reading list

McMurry: Organic Chemistry
Hadad, Craine, Hart and Hart: Organic Chemistry
McMurry, 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; oral discussion; laboratory 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 January 2015

BE_09 Biochemistry

Study semester:	**2** (full time) **2** (cooperative) **2** (part time)	**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**

Coordinator

Prof. Dr. habil. Christoph Böhmer

Instructors

Prof. Dr. habil. Christoph Böhmer

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

Intended learning outcomes

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

Fundamentals of Chemistry (BE_02)

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, CK: Biochemistry

Examination

Graded exam

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 January 2015

BE_10 Bioengineering Physics

Study semester:	**2** (full time) **2** (cooperative) **2** (part time)	**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**

Coordinator

Prof. Dr. Björn Neu

Instructors

Prof. Dr. Björn Neu

Contents

Lecture/Exercises:
wave motion, diffraction, interference, diffraction grating; special theory of relativity; early quantum theory; thermal radiation and Planck's quantum hypothesis; Einstein's photon theory; wave properties of particles; quantum mechanics of atoms; basic principles of nuclear physics; radioactivity, decay processes, dosimetry

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

Intended learning outcomes

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

None

Reading list

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

Examination

Graded exam

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 January 2015

BE_11 Applied Microbiology

Study semester:	**2** (full time) **4** (cooperative) **4** (part time)	**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**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Prof. Dr. Joachim Fensterle

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; bioconversion: production of DHA from glycerol

Intended learning outcomes

On successful completion of this module, students should

- know the importance of microorganisms in biotechnology[1]
- expand their knowledge of distribution, characteristics and biotechnological and medical relevance of microorganisms[1,2]
- 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

Cell Biology and Microbiology (BE_01)

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

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 January 2015

BE_12 Applied Mathematics

Study semester:	**2** (full time) **2** (cooperative) **2** (part time)	**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**

Coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Instructors

Prof. PD Dr.-Ing. Sylvia Moenickes; Christoph Knoblauch, M.Sc.

Contents

Integral calculus, esp. substitution rule, integration by parts, partial fraction decomposition, improper Integral; Power series, esp. Taylor series, approximation by partial sums, numeric aspects; Differential calculus of multiple variables, esp. partial derivatives, gradient, total differential, application error propagation, extrema; Ordinary differential equations, esp. slope field, Euler method, separation of variables, first and second order linear differential equations; Linear algebra, esp. matrices, determinants, inverse of a square matrix

Intended learning outcomes

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]
- recognize the additional benefit of mathematics: mathematical formulation and processing of a problem deliver additional insights, which might have been missed[2]
- improve their social competence by group homework and train their communication skills with the help of exact mathematical formulation[2,3]
- improve 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

Mathematics and Statistics (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

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 April 2016

BE_13 Physical Chemistry

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

Coordinator

Prof. Dr. Björn Neu

Instructors

Prof. Dr. Björn Neu

Contents

Lecture/Exercises:
chemical thermodynamics (the First Law, the Second Law, phase equilibria, chemical equilibrium); enzyme kinetic; rates of reactions; biomolecular structure; macromolecules and self-assembly

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

Intended learning outcomes

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

Basics of Physics (BE_03); Bioengineering Physics (BE_10)

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

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 January 2015

BE_14 Instrumental Analytics

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

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

Dr. Stefan Weber

Contents

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; data evaluation and interpretation with respect to quality assurance

Intended learning outcomes

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]

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

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03); Applied Chemistry (BE_08)

Reading list

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

Examination

Graded exam

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 2018

BE_15 Measurement and Control Engineering

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

Coordinator

Prof. Dr.-Ing. Frank Platte

Instructors

Prof. Dr.-Ing. Frank Platte

Contents

Lecture:
tasks, goals and application of measurement and control engineering; mathematical modeling of technical systems using differential equations; 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; systems with deterministic and stochastic variables; 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, frequency response plot, Nyquist plot, Bode diagram; dynamic and steady state behaviour of linear continuous control systems; stability of linear continuous control systems: definition of stability and stability condition, Hurwitz criterion, Routh criterion, Nyquist criterion; design process for linear continuous control systems

Lab course:
analysis and synthesis of control loops using Matlab/Simulink; electromagnetic levitation (floating sphere)

Intended learning outcomes

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 Matlab/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; lab course with lab reports

Entrance requirements

Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03)

Reading list

Hespanha: Linear Systems Theory
Franklin, Powell and Emami-Naeini: Feedback Control of Dynamic Systems
Astrom and Murray: Feedback Systems: An Introduction for Scientifics and Engineers

Examination

Graded exam

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 2018

BE_16 Process Engineering

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

Workload

Contact time		Self-study	
Lecture	45 h	Preparation for contact time	25 h
Exercise	30 h	Literature review	15 h
		Preparation for exams	35 h
Sum	75 h	Sum	75h

Total workload: **150 h**

Coordinator

Prof. Dr.-Ing. Frank Platte

Instructors

Prof. Dr.-Ing. Frank Platte; Dr. Peter Henselder

Contents

Basics of Process Engineering: Chemical reactors: continuous and discontinuous operation, reactor and reaction type, evaluation criteria for operating performance of chemical reactors (capacity, conversion rate, selectivity, yield rate, performance, space-time-yield); Reaction kinetics of homogeneous reactions: reaction equation, chemical reaction rate, approach for reaction-kinetic equation (irreversible, equilibrium reaction), temperature dependence of rate constants, determination of reaction rate; Ideal reactors without heat of reaction: bases of calculation, ideal stirred reactor, discontinuous operation (calculation, maximization and optimization), ideal plug flow reactor, continuous operation (calculation), ideal stirred reactor, continuous operation (stoichiometric addition of components, addition of component in excess), comparison of sizes of ideal reactors; Connection of ideal reactors: cascade of stirred reactors of same size (analytical, graphical solution), cascade of stirred reactors of different size, serial and parallel connection of ideal plug flow reactors, upstream reactor and separation unit; Non-ideal reactors; Influence of heat of reaction: reaction enthalpy (heat of reaction), energy balance, ideal stirred reactor, discontinuous operation (isothermal-isobaric reactor operation, adiabatic-isobaric reactor operation), ideal plug flow reactor, continuous operation (isothermal-isobaric reactor operation, adiabatic-isobaric reactor operation), ideal stirred reactor, continuous operation (stationary working point, stability of continuously operated stirred reactor, hysteresis; Optimal temperature control of reversible, exothermal reactions: ideal stirred reactor, continuous operation, cascade of stirred reactors, continuous operation, ideal plug flow reactor, continuous operation

Fluid Mechanics: Basics: fluid properties, Newtonian and non-Newtonian fluids, viscosity measurement, fluid statics; fluid flow: flow phenomena, water hammer, compressible fluids; piping, seals, and valves: friction and piping, gaskets and mechanical seals, valves; flow measurement; pumps ejectors, blowers, and compressors; mixing; two-phase flow systems

Intended learning outcomes

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

Entrance requirements

Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03)

Reading list

Smith and Harriot: Unit Operations of Chemical Engineering
Smith: Chemical Process: Design and Integration
Raju: Fluid Mechanics, Heat Transfer, Mass Transfer: Chemical Engineering Practice

Examination

Graded exam

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 2018

BE_17 Basics of Economic Sciences

Study semester:	**3** (full time) **5** (cooperative) **7** (part time)	**Credit Points (ECTS):**	**5**

Workload

Contact time		Self-study	
Lecture	60 h	Preparation for contact time	40 h
Exercise	15 h	Literature review	15 h
		Preparation for exams	20 h
Sum	75 h	Sum	75 h

Total workload: **150 h**

Coordinator

Prof. Dr. Frank Schmitz

Instructors

Prof. Dr. Marcel Friedrich; Dr. Courage Ijehgde

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

Marketing: Basics of marketing; behavior and information background of marketing; strategic marketing planning; marketing-mix; implementation and controlling of marketing

Intended learning outcomes

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]
- be able to recognize ethical principles in connection with economic action[1-2]
- be able to calculate elasticity[1-4]
- 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]
- be able to develop independently and to present professionally marketing concepts[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

Basics of Management (BE_05)

Reading list

Horváth, Peter: 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

Examination

Graded exam

Teaching materials and media

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

Areas of competence

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

last amended October 2018

BE_18 Applied Management

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Alexandra Schollmeier

Contents

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

Conflict Management: types of conflicts: conflict of leadership and objectives; symptoms and dynamics of conflicts; conflicts in intercultural operational interaction or in multicultural teams in companies; behavior and attitudes in conflicts; conflict resolution strategy; conflict prevention; motivation theories and corresponding courses of action

Intended learning outcomes

On successful completion of this module, students should

- 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 differ between different types of conflicts[1,2]
- handle problem-solving moderation techniques[3]
- recognize conflict situations and know how to deal with these[1,2]
- be able to apply methods to settle disputes and to prevent escalation[1,3]
- recognize their own conflict style, be able to reflect their style and to develop appropriate coping strategies[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

Basics of Management (BE_05)

Reading list

Folger, Poole and Stutman: Working through conflict; Strategies for relationships, groups and organizations
Berko, Wolvin and Wolvin: Communicating; A social, career and cultural focus

Examination

Testate

Teaching materials and media

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

Areas of competence

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

last amended October 2018

BE_19 Bioprocess Engineering

Study semester:	**4** (full time) **6** (cooperative) **4** (part time)	**Credit Points 8ects9:**	**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**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Prof. Dr. Joachim Fensterle

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

Intended learning outcomes

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

Applied Microbiology (BE_11), Applied Mathematics (BE_12), Process Engineering (BE_16)

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

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 January 2015

BE_20 Enzyme Engineering

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

Dr. David James Onyango

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; 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

Intended learning outcomes

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]
- gain 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

Biochemistry (BE_09)

Reading list

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

Examination

Graded exam

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 April 2018

BE_21 Project 2

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**10**

Workload

Contact time		Self-study	
Lectures	120 h	Preparation for contact time	90 h
		Literature review	20 h
		Preparation for exams	70 h
Sum	120 h	Sum	180 h

Total workload: **300 h**

Coordinator

Prof. Dr. Björn Neu

Instructors

All instructors of the faculty

Contents

Several biotechnological project themes will be available to choose from in order to deepen the knowledge in scientific or engineering disciplines. The students work in small groups of 5 to 10 people. The content of the projects vary depending on the topic. Focus will be on group work, project planning and implementation, methods and documentation of scientific work, final report, status seminars and oral final presentation.

Intended learning outcomes

On successful completion of this module students

- should have gained experience with project organization, team work, and project implementation[1,3]
- should know the basics to document scientific work[4]
- should have deepened specialized knowledge[1,3,4]
- should have established/improved social competence and the ability to work in a team[3]

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

Teaching and learning methods

Group work; self-study; lab work and excursions depending on topic; presentations of the students

Entrance requirements

Basics of Management (BE_05); Applied Management (BE_18); 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 upon constant participation at project work; collaboration on status report; final report and protocol

Teaching materials and media

Beamer; white/black board; flipchart; visualisation aids for presentation; internet search; expert meetings; interviews; specialised literature; appropriate lab equipment if required

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 2013

BE_22 Downstream Processing

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Martin Krehenbrink

Contents

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)

Intended learning outcomes

On successful completion of this module, students should

- gain 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

Biochemistry (BE_09); Bioprocess Engineering (BE_19)

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

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 2016

BE_23 Industrial Biotechnology

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Prof. Dr. Joachim Fensterle; Dr. Peter Schiener

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

Intended learning outcomes

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]

[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

Biochemistry (BE_09); Applied Microbiology (BE_11)

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

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 2016

BE_24 Basics of Law

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

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Ulrike Wenzel-Daugsch

Contents

Employment law: History and basics of employment law; legal basis of employment; initiation of employment; contents of employment contracts; rights and obligations of employment contract parties; cessation of employment

Safety and liability law: definition and kinds of safety; safety engineering and its applications; legal basis of occupational safety; technical rules, accident prevention regulation, DIN-standards, labor law protective and safety provision; liability law in application area of German civil code; EU chemicals regulation REACH

Company law: introduction to company law; European company law; BGB company; ordinary partnership; limited partnership; dormant partnership; stock company; partnership limited by shares; close corporation; registered cooperative; conversion of corporate entities; foreign legal forms

German civil code: outline of German civil code; structure; general principles of civil law; legal capacity and capacity to contract; contract conclusion; procuration; invalidity; defeasibility; cancellation and lapse of time with respect to central norms of law of obligation; construction of contracts and laws and filling of gaps

Patents and patent law: prerequisites of patents; definition of invention; German employee invention law; 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

Intended learning outcomes

On successful completion of this module, students should

- know the basics of employment law and the elements of employment from placement to cessation as well to be able to apply this knowledge with respect to job advertisements and employment contracts[1,2,3]
- know the various types of safety, details of safety engineering and legal provisions of occupational safety[1]
- know the legal guidelines of safety and be able to meet these in particular at the workplace[2,3]
- know the basics of liability according to civil law which result from neglecting legal provisions[1]
- get insight in structure and principles of the civil code[1]
- be able to read and to interpret legislative texts and contracts[2,4]
- know the most important types of company law and their prerequisites as well as the advantages and disadvantages in the course of business[1,2]
- 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]

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

Teaching and learning methods

Lecture; self-study; group work; exercises

Entrance requirements

None

Reading list

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; project work

Teaching materials and media

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

Areas of competence

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

last amended August 2015

BE_25 Integrated Management Systems and Quality Management

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

Workload

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

Total workload: **150 h**

Coordinator

Prof. Dr. Rudolf Schumachers

Instructors

Dr: Bernd Kimpfel

Contents

Basic management principles; basics of management systems; process orientation; development and characteristics of national and international standards and norms of management systems; documentation of company organization structure and process organization; procedures and methods of system controlling und assessment; approach to install application-oriented and networked management systems; quality management, environmental management, occupational safety management

Intended learning outcomes

On successful completion of this module, students should

- know the structure, the characteristics and the legal framework requirements of the most important management systems[1]
- know the relevant national and international standards and guidelines to establish management systems[1]
- be able to identify the essential differences between different management systems[2]
- apply procedures and methods for analysis and improvements[3]
- apply procedures to develop practice-oriented problem solvings[3]
- implement methods to control and assess processes and systems[3,4]
- develop and evaluate process-oriented and networked management systems[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

International Project Management (BE_05)

Reading list

International Standards ISO 9000 ff, 14000 ff, 19011
Guidelines on Occupational Safety and Health Management Systems, ILO-OSH 2001, Geneva
Forster and Browne: Principles of Strategic Management
Jackson: The ISO 14001 Implementation Guide
Harrington: Business Process Improvement
Ishikawa: What is Total Quality Control? The Japanese Way
Ohno: Toyota Production System
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

Teaching materials and media

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

Areas of competence

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

last amended January 2015

BE_26.1 Technical Enzymology

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

Dr. David James Onyango

Contents

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; mechanisms of protein stabilization

Intended learning outcomes

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]
- be able to design methods to improve enzyme function in the industrial environment[3,4,5]
- research a leading-edge application of enzyme technology and present and discuss the results in an oral presentation[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

Enzyme Engineering (BE_20)

Reading list

Aehle: Enzymes in Industry: Production and Applications
Polaina and MacCabe: Industrial enzymes: structure, function and applications

Further literature will be provided by the lecturer.

Examination

Graded exam

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 April 2018

BE_26.2 Biofuels

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Matthias Kleinke

Instructors

Prof. Dr. Matthias Kleinke

Contents

Renewable energy sources compared to fossil resources, Biomass feedstock and intermediates of Biofuels, properties and utilisation, production processes: conventional and lignocellulosic ethanol production, transesterification, Biomass-to-Liquid (BTL) conversion, methanol, DME, DMC synthesis, combustion, carbonisation and gasification of biomass, anaerobic fermentation, production costs, GHG emissions, Sustainability of biofuel production and utilisation

Intended learning outcomes

On successful completion of this module, students should

- 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

None

Reading list

Literature will be provided by the lecturer

Examination

Graded exam

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 May 2013

BE_26.3 Agricultural Biotechnology

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Dr. Peter Schiener

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- 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]

[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

None

Reading list

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

Examination

Graded exam

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 April 2017

BE_26.4 Cellular Biophysics

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Björn Neu

Instructors

Timo Preißing

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- understand the basic theories and methods of cellular biophysics[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

None

Reading list

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

Examination

Graded exam

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 October 2018

BE_26.5 Medical Bioengineering

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Prof. Dr. Joachim Fensterle

Contents

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

Intended learning outcomes

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]

[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

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, graded presentation

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 May 2013

BE_26.6 Nanobiotechnology

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Kerstin Koch

Instructors

Prof. Dr. Kerstin Koch

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; 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.

Intended learning outcomes

On successful completion of this module, students should

- know the main fields of nanotechnology use[1]
- are able to discuss the advantages and potential risk on nanomaterial use[2]
- know examples of nanomaterial's and their specific attributes[1]
- 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

Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03)

Reading list

Schulz, Shanov and Yun: Nanomedicine Design of Particles, Sensors, Motors, Implants, Robots, and Devices
Sellers, Mackay and Bergeson: Nanotechnology and the Environment
Manasi Karkare: Nanotechnology: Fundamentals and Applications
Further literature will be provided by the lecturer

Examination

Graded 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 June 2015

BE_26.7 Modeling of Dynamic Systems

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. PD Dr.-Ing. Sylvia Moenickes

Instructors

Prof. PD Dr.-Ing. Sylvia Moenickes

Contents

Discrete and continuous models of processes; Continuous models: linear and higher order models, compartment schemes, superposition; Discrete models: Cellular automata; stationarity and stability of systems, sensitivity; Models in time and space, multi-dimensional models

Intended learning outcomes

On successful completion of this module, students should

- know how to mathematically describe dynamic processes[1]
- be able to set up non-linear multidimensional and multi-compartment models[2,3]
- be able to analyse a given system with respect to stationarity, 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

Entrance requirements

Mathematics and Statistics (BE_04); Applied Mathematics (BE_12)

Reading list

Literature will be provided by the lecturer

Examination

Graded exam

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 May 2013

BE_26.8 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

All lecturers of the university

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- acquire knowledge from other areas of the university and deepen or enlarge 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]
- 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

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			X

last amended May 2013

BE_26.9 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study semester:	**4** (full time) **6** (cooperative) **6** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

All lecturers of the university

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- acquire knowledge from other areas of the university and deepen or enlarge 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]
- 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

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			X

last amended May 2013

BE_27.1 Biocatalysis

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

Dr. Peter Schiener

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- 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 presentation

Entrance requirements

Applied Chemistry (BE_08); Biochemistry (BE_09); Enzyme Engineering (BE_20)

Reading list

Bommarius, Riebel: Biocatalysis: Fundamentals and applications
Tao, Kazlauskas: Biocatalysis for Green Chemistry and Chemical Process Development
Further literature will be provided by the lecturer

Examination

Graded exam

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 October 2016

BE_27.2 Metabolic Engineering

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. habil. Mònica Palmada Fenés

Instructors

Dr. Georg Lentzen

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;

Intended learning outcomes

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

Biochemistry (BE_09); Applied Microbiology (BE_11)

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

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 October 2016

BE_27.3 Biopolymers

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

Prof. Dr. Peter F. W. Simon

Contents

Detailed knowledge of the structure, function, properties, and use of biopolymers; molecular architecture of typical biological materials such as starch and rubber; biomimetic approach for polymeric materials; biomedical materials including “drug delivery” concepts; biodegradation of polymeric materials; comparison of the environmental impact of biopolymers and synthetic polymers.

Intended learning outcomes

On successful completion of this module, students should

- explain and evaluate biopolymer properties based on their molecular structure.[1,2]
- identify specific biopolymers to biological structures in nature.[2,3]
- describe the process and explain the environmental impact of biodegradation processes.[3,4]
- reflect on the polymeric material choices for biomedical applications.[3,4]
- suggest and discuss the choice of biopolymers vs. synthetic polymers suitable for common applications with respect to material properties, function, environmental impact, recycling, and economy.[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

Fundamentals of Chemistry (BE_02); Basics of Physics (BE_03); Applied Chemistry (BE_08); Instrumental Analytics (BE_14)

Reading list

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

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 May 2013

BE_27.4 Environmental Biotechnology

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Dr. Peter Schiener

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- 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]

[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

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

Examination

Graded exam

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 October 2018

BE_27.5 Microalgae

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Dr. habil. Waltraud Kofer

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- 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

None

Reading list

Lee: Phycology
Bellinger and Sigee: Freshwater algae: identification and use as bioindicators
Gouveia: Microalgae as a Feedstock for Biofuels

Examination

Graded exam

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 October 2018

BE_27.6 Immunology

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Joachim Fensterle

Instructors

Prof. Dr. Joachim Fensterle

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- 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[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

Genetics and Molecular Biology (BE_07); Biochemistry (BE_09)

Reading list

Abbas: Cellular and Molecular Immunology

Examination

Graded exam

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 May 2013

BE_27.7 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

All lecturers of the university

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- acquire knowledge from other areas of the university and deepen or enlarge 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]
- 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

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			X

last amended May 2013

BE_27.8 Module from any Bachelor Study Course at Rhine-Waal University of Applied Sciences

Study semester:	**5** (full time) **7** (cooperative) **7 or 9** (part time)	**Credit Points (ECTS):**	**3**

Workload

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

Total workload: **90 h**

Coordinator

Prof. Dr. Peter F. W. Simon

Instructors

All lecturers of the university

Contents

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

Intended learning outcomes

On successful completion of this module, students should

- acquire knowledge from other areas of the university and deepen or enlarge 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]
- 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

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			X

last amended May 2013

BE_28 Internship or study abroad

Study semester:	**6** (full time) **8** (cooperative) **1–7** (part time)	**Credit Points (ECTS):**	**30**

Workload

Contact time	Self-study
Sum	Sum 900 h

Total workload: **900 h**

Coordinator

Prof. Dr. Björn Neu

Instructors

All lecturers of the Faculty of Life Sciences

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, ecological, ethical and security aspects. 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.

Intended learning outcomes

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

Depends on selected activity

Reading list

Depends on selected activity

Examination

Internship: written report

Study abroad: successful completion of 15 ECTC, written report and presentation after return

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 January 2015

BE_29 Workshop

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

Workload

Contact time		Self-study	
Lecture	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**

Coordinator

Prof. Dr. Björn Neu

Instructors

Prof. Dr. habil. Christoph Böhmer

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

Intended learning outcomes

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]
- become 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

None

Reading list

Literature will be provided by lecturer

Examination

Certificate

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 September 2018

BE_30 Bachelor Thesis

Study semester:	**7** (full time) **9** (cooperative) **8** (part time)	**Credit Points (ECTS):**	**12**

Workload

Contact time	Self-study
Sum	Sum 360 h

Total workload: **360 h**

Coordinator

Prof. Dr. Björn Neu

Instructors

All lecturers of the faculty

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.

Intended learning outcomes

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]
- implement technical knowledge in a scientifically appropriate way[3,4]
- 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

Depending on chosen subject/task; minimum of 175 ECTS

Reading list

Depending on chosen subject/task

Examination

Written thesis of approx. 40–100 pages

Teaching materials and media

Specific

Areas of competence

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

last amended May 2013

BE_31 Colloquium

Study semester:	**7** (full time) **9** (cooperative) **9** (part time)	**Credit Points (ECTS):**	**8**

Workload

Contact time	Self-study
Sum	Sum 240 h

Total workload: **240 h**

Coordinator

Prof. Dr. Björn Neu

Instructors

All lecturers of the faculty

Contents

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

Intended learning outcomes

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

Bachelor thesis; minimum of 202 ECTS

Reading list

Depending on chosen subject/task

Examination

Oral exam

Teaching materials and media

Specific

Areas of competence

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

last amended May 2013