Important note: In the following we provide English translations of the module descriptions of the V-modules. These translations are for orientation purposes only and may not be up-to-date. Only the German module descriptions are legally binding.

Table of contents

EXPLANATIONS AND COURSE OF STUDIES

Dear biology students,

the following module descriptions, which can be taken in accordance with the examination regulations that will apply from winter semester 2018/19, contain important information on the individual modules, in particular on

- The responsibility and organization of the modules (contact persons, type of enrollment)
- The content (expertise) and the learning outcomes (skills, abilities, competences) of the modules
- The type and scope (workload) of the courses and examination modalities
- Required (formal) and desired (content) prerequisite to participate in the module

This additional information is intended to help you choose the specialisation modules and plan your studies.

ADVANCED MODULES

The total workload of the BBIO variant is 180 CP. In the variant, the basic phase is followed by the advanced phase. Three advanced modules (V-modules) are selected. These V-modules are usually offered for four weeks with all-day blocked practical courses. In most modules there is a two-week attendance phase with all-day practical courses and lectures. Subsequently, students are expected to spend two weeks of self-study, during which, for example, protocols are written, seminar presentations are given and examinations are written. The V-modules serve to deepen the basic knowledge in several areas of biology, as well as intensive preparation for the subsequent everyday laboratory work. In particular, the V-modules encourage students to solve problems independently, to extend their methodological competence, to deepen their knowledge, to develop teamwork skills and their oral and written presentation skills. The thematic orientation of the V-modules is largely based on the research fields of the institutes and working groups. As a rule, the modules are chosen from the electronic course catalogue LSF.

EXPLANATORY NOTES ON THE SUBHEADING COURSE LANGUAGE:

☒ German
The language of instruction/examination is German.

☒ English
The language of instruction/examination is English. Exceptions or additional possibilities are pointed out in the respective module descriptions.

☒ German and English
Both teaching languages are used.
As a rule, the examinations are held in German.

☒ German, English if required/on demand
The language of instruction is German. If a participant does not speak German, the course will be held in English. The language of the examination will be agreed upon individually with the participants.

☒ English
☒ German
The language of instruction/examination can be either German or English (e.g. the Bachelor thesis can be written in English or German).

V403

V403 - Genomik und Molekularbiologie der Pflanzen

V403 - Genomics and Molecular Biology of Plants

Coordinator (responsible lecturer) Prof. Dr. Peter Westhoff (west@hhu.de)			**Status:** 02.07.2018
Lecturers Dr. Stefanie Schulze and others			**Semester:** 5. – 6.
Contact and organization Dr. Stefanie Schulze (stefanie.schulze@hhu.de)			**Mode:** Optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students can describe and explain basic concepts and methods of genomics and molecular biology of plants. They carry out simple molecule larbiological and genetic experiments/techniques under guidance. They precisely document and evaluate the experiments carried out. The students are able to work independently and properly with the basic measuring instruments and other apparatus and instruments from the laboratory. The students are able to work with scientific texts and present their contents in an understandable way in a lecture.

Forms of teaching

Practical course, Lecture, Seminar

Content

Lecture:

- Molecular biological and genomic methods: restriction enzymes, recombinant cloning, cloning vectors, PCR, cDNA cloning
- Transcriptional gene regulation in the nucleus and plastids (promoters, enhancers, general and regulatory transcription factors, differential gene expression)
- Posttranscriptional gene regulation in nucleus and plastids: RNA processing (5' and 3' modifications of transcripts, introns and RNA splicing, RNA editing), translation control (translation cycle, RNA quality control), regulatory RNAs
- Genetic analysis of biological functions: Forward genetics, reverse genetics (transcriptome analysis [DNA microraster, RNA-Seq], proteome analysis [2D electrophoresis, mass spectrometric methods], interactome analysis [2-hybrid systems, epitope labelling of proteins and affinity chromatographic purification])

Practical course:

(1) Amplification of DNA by PCR; reaction conditions and primer analysis
(2) Cloning of DNA and sequence analysis.
(3) Analysis of RNA: northern-hybridization and semi-quantitative RT-PCR.
(4) Protein analysis: SDS gel electrophoresis and immunoblotting.

Seminar:

- Gateway cloning
- DNA sequencing
- Transcription factors; classes and mode of action
- Regulatory RNAs
- Model system Arabidopsis thaliana
- Yeast two-hybrid system
- Mass spectrometry

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion;
(3) skill area scientific presentation (10% of grade): preparation, presentation and discussion of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation in the practical course
(3) Punctual submission of scientific protocol
(4) Regular participation in the seminar and giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V404

V404 - Allgemeine Mikrobiologie

V404 - General Microbiology

Coordinator (responsible lecturer) Prof. Dr. Michael Feldbrügge **(feldbrue@hhu.de)**			**Status:** 01.10.2018
Lecturers Prof. Dr. Michael Feldbrügge			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Michael Feldbrügge **(feldbrue@hhu.de)**			**Mode:** Optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

The students have comprehensive knowledge of the molecular biology of phages, bacteria and eukaryotic microorganisms. Students can apply classical and basic genetic engineering methods to microorganisms whose theoretical background was presented to the students in the lecture. The students are able to implement the experimental specifications and carry out the individual experimental steps. The students are able to work independently and properly with the basic measuring instruments and other apparatus and instruments from the laboratory. Students can record their results and discuss them with the help of current literature. The students are able to plan, create and present a target group-oriented presentation on a given topic of general microbiology.

Forms of teaching

Practical course, Lecture, Seminar

Content

Lecture:

Bacteriophages: structure, cycles, transduction, plaques, eclipse, temperente phages, lambda regulation, conversion, phage display, applications; bacterial genetics: mutation, recombination, auxotrophy, conjugation, transformation, transduction, competence, plasmids, cosmids, artificial yeast chromosomes, cloning, applications; cell surface of bacteria: Structures/biosynthesis LPS, fimbria, flagella, phase variation by recombination, methylation, insertion/deletion; chemotaxis forms/flow/2 component system, transport pores, symport, phosphotransferase, binding protein dependence; classical yeast genetics: Development, complementation, recombination, plasmids, mitochondria; molecular genetics of yeast: genetic elements, vectors, gene regulation; molecular biology: cloning strategies, PCR. Bacterial regulation: transcription, two-component systems, quorum sensing, operon. Genomics: genome sequencing, annotation.

Practical course:

Bacteria enrichment from soil; enzyme tests, bacterial transformation; Ames test; mutagenic

substances, penicillin enrichment of mutants; isolation of phage from wastewater; plaque morphology, phage transduction using the example of P1; yeast crossing, complementation, mitotic recombination, gene selection, auxotrophy markers; amino acid permeases, gene cloning; dual hybrid system, alcoholic fermentation.

Seminar:

Methodological aspects of general microbiology are discussed on the basis of textbooks and original publications. These aspects are closely related to the topics of the lecture and the practical course. Students give a presentation and discuss the presentation in the group.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic knowledge of microbiology from Bio240 is required.

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (30% of grade): Protocol: Topics, Implementation, Evaluation and Discussion of Scientific Experiments;

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation in preliminary discussions and practical course
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☒ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V406	V406 - Der Zellkern: Struktur, Funktion und seine Rolle bei neurodegenerativen Aggregat-erkrankungen
	V406 - The Cell Nucleus: Functional Organization and its Role in Neurodegenerative Diseases

Coordinator (responsible lecturer) Prof. Dr. Anna von Mikecz (mikecz@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Anna von Mikecz			**Semester:** 5. – 6.
Contact and organization Annette Piechulek (annette.piechulek@uni-duesseldorf.de)			**Mode:** Optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer- and every winter-term	**Group size** 4	**Duration** 1 semester

Learning outcomes/skills

Students can describe the basic concepts of the functional organization of the cell nucleus and apply the acquired methodological knowledge in practice. Students can precisely document and evaluate the experiments performed. They can independently work out a given topic with the aid of English technical literature and present it in an understandable way.

Forms of teaching

Practical course, Lecture, Seminar

Content

Lecture:

(1) Introduction to nuclear processes: DNA repair, transcription, splicing of RNA, nucleocytoplasmic transport, nuclear domains / microenvironments, nuclear Proteolysis.
(2) Introduction to protein degradation by the ubiquitin-proteasome system; demarcation lysosomal proteolysis, autophagy and protein degradation in mitochondria.
(3) Disturbance of protein homeostasis as cause of intracellular protein aggregation, amyloid protein fibrillation and neurodegenerative pathomechanisms Aggregate diseases.
(4) The neural system of the threadworm Caenorhabditis elegans; the importance of C. elegans as an animal model for neurodegeneration and neurotoxicity.

Practical course:

(1) Indirect immunofluorescence of endogenous proteins and reporters - C. elegans using different microscopic methods and data analysis with analysis software.
(2) Biochemical fractionation of C. elegans and characterization of proteins by Western blotting.
(3) Analysis of components of the ubiquitin proteasome system and proteasomal activity in C. elegans.
(4) Cultivation of C. elegans and observation of neural behavioral phenotypes.

Seminar:

Selected original and review papers on the functional organization of the cell nucleus, the ubiquitin proteasome system and protein aggregation diseases.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (80% of grade): oral examination about the contents of the lecture and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (10% of grade): preparation and presentation of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation in the practical course
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
Place: IUF - Leibniz Institut für umweltmedizinische Forschung

V409

V409 - Molekulare Populationsgenetik

V409 - Molecular Population Genetics

Coordinator (responsible lecturer)
Prof. Dr. Martin Beye (Martin.Beye@uni-duesseldorf.de)

Status:
01.10.2018

Lecturers
Prof. Dr. Martin Beye

Semester:
5. – 6.

Contact and organization
Prof. Dr. Martin Beye (Martin.Beye@uni-duesseldorf.de)

Mode:
Optional compulsory module

Workload	Credit points	Contact time	Self-study
270 h	9 CP	120 h	150 h

Course components		Frequency	Group size	Duration
Practical course:	6 SWS	every winter-term	16	1 semester
Lectures:	1 SWS			
Seminars:	1 SWS			

Learning outcomes/skills
Students will be able to use common molecular techniques (PCR, restrictions, cloniations, sequencing) to generate nucleotide sequences of genes. They can develop simple hypotheses and test them using experiments and statistical tests. Students can analyze sequence data and explain the causes and distribution of sequence differences in genes. They know the theoretical basics of genetics and population genetics.
Students will be able to create a target group-oriented presentation on a given topic of molecular population genetics and present it to a group.

Forms of teaching
Lecture and practical work in the laboratory and computer center, presentation.

Content
Lecture:

(1) Diversity of characteristics in populations, significance of polymorphisms (diseases, adaptation, history of incarnation, QTL mapping), detection of polymorphisms (from organism to DNA), describe new sequencing methods.
(2) Explain which mechanisms determine the degree and distribution of polymorphisms.
(3) Explain the processes mutation, selection, genetic drift, "gene flow" theoretically, experimentally and with examples.
(4) The importance for the sequence evolution of genes between species and within species. Examples: the human population structure: Incarnation, genes in honeybees and fruit flies: function/selection relationship.
(5) Population genetic methods to detect selection in DNA sequences, deviation from neutral expectation (theory and examples): McDonald-Kreitman-Test, nonsynonymous to synonymous ratios, Tajima's D.

Practical course:

(1) Students learn basic molecular genetic techniques.
(2) Students will learn to independently analyze sequence information, generate hypotheses, model, and apply common statistical tests.
(3) Students learn how to use common population genetic programs (e.g. Mega, DnaSp) to analyze sequence differences at their own PC workstations. The algorithms used are explained and statistical test procedures are learned. Furthermore, the handling of databases (e.g. NCBI, FlyBase, Prosite) is trained.
(4) Students will learn to predict the function and evolutionary history of genes based on sequence information.

Seminar:

Lecture series on the evolutionary development of developmental processes and diseases, History of species.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic knowledge of genome organisation is assumed.

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (80% of grade): written examination about the content of the lectures and the practical course;
(2) skill area scientific presentation (20% of grade): Seminar presentation (development of the material, graphic presentation of the contents, lecture, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge.
(2) Regular and active participation in the practical course and presentation of its results as a short presentation.
(3) Giving a scientific presentation.

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V411	V411 - Gundlagen der eukaryotischen Mikrobiologie I V411 - Principles of Eucaryotic Microbiology I		
Coordinator (responsible lecturer) Prof. Dr. Ursula Fleig (fleigu@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Ursula Fleig			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Ursula Fleig (fleigu@uni-duesseldorf.de)			**Mode:** Optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Upon successful completion of the module, the students will be able to reproduce and explain the contents of the lecture and the theory of practical experiments. The equipment used in the practical course can be used by the students to explain the underlying theory. The students are able to explain basic scientific questions of the microbiology of eukaryotes.

Forms of teaching

Lecture, Practical course

Content

Lecture:

Cell growth and polarized cell shape: role of the microtubule and actin cytoskeleton. Intrinsic and extrinsic control of cell growth. Cell cycle and cell cycle control. Mitosis and aneuploidy prevention. Yeast as eukaryotic model system.

Practical course:

Growth of yeasts: Growth curves, determination of generation time under different conditions, vegetative propagation, haploid, diploid yeasts, mating, dimorphism and filamentous growth, entry into meiosis and sporulation, crosses with tetrad and random spore analyses, auxotrophy selection markers. Yeast cell cycle: Cell cycle mutants (cdc) of S. cerevisiae and S. pombe, determination of cell cycle stages of wild typical and arrested cdc mutants by microscopy and flow cytometry.
Yeast genetics: Complementation of a conditional lethal mutant with a yeast gene bank,

transformation of the gene bank and selection of the gene bank plasmids into the relevant yeast strain; selection for growth under conditional conditions. Isolation of suppressive plasmids from yeast, amplification in E.coli, Restriction enzyme analysis and DNA sequence analysis as well as bioinformatic analysis.
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** None
Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course; (2) skill area of Application of the acquired knowledge (30% of grade): exercises on experiments from the practical course.
Requirements for the award of credit points for this course (1) Regular attendance (lectures and practical course) (2) Pass written examination of skill area knowledge (3) Punctual submission of scientific protocol
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V413	V413 - Genetische Grundlagen der Musterbildung während der Entwicklung von Invertebraten
	V413 - Genetic Mechanisms of Pattern Formation during Invertebrate Development

Coordinator (responsible lecturer) Prof. Dr. Thomas Klein (Thomas.Klein@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Thomas Klein (Thomas.Klein@uni-duesseldorf.de), Dr. André Bachmann (Andre.Bachmann@uni-duesseldorf.de)			**Semester:** 5. – 6.
Contact and organization Dr. André Bachmann (Andre.Bachmann@uni-duesseldorf.de)			**Mode:** Optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer- and every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills
The students are able to describe and explain basic mechanisms of pattern formation in Drosophila melanogaster. They are able to carry out independently selected genetic and histochemical experiments of a developmental biological nature.

Forms of teaching
Lecture, practical course with independent experiments, preparation of an essay on the pattern formation processes examined in the practical course. The results and pictures achieved during the practical course are incorporated.

Content
The module examines basic principles and strategies of pattern formation using the model organism Drosophila melanogaster as an example. Students will learn genetic and histochemical analysis techniques such as antibody staining, X-Gal staining, in situ hybridization, mosaic analysis and methods of ectopic gene expression. Presentation and evaluation are carried out using modern light microscopic methods (fluorescence and confocal microscopy).

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course; (2) skill area Application of Acquired Knowledge (30% of grade): Evaluation of the essay
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular participation (3) The experiments carried out must be presented completely and correctly in the form of an essay (competence area 'application of acquired knowledge').
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V415	V415 - Molekularbiologische Techniken am Beispiel von Drosophila melanogaster V415 - Molecular Techniques in Drosophila melanogaster

Coordinator (responsible lecturer) Prof. Dr. Thomas Klein (Thomas.Klein@uni-duesseldorf.de)			**Status:** 27.03.2019
Lecturers Prof. Dr. Thomas Klein, Dr. André Bachmann			**Semester:** 5. – 6.
Contact and organization Dr. André Bachmann (Andre.Bachmann@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills
Students will be able to explain and apply basic procedures for identifying and characterising a gene. For this purpose, they independently carry out molecular biological, biochemical and histochemical experiments using the example of Drosophila melanogaster. The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context.

Forms of teaching
Lecture, practical course with independent experiment, preparation of a protocol

Content
General genetic, molecular biological and biochemical methods for gene identification and characterization from mutation to gene. In practical experiments the students independently perform biochemical, cell and molecular biological techniques such as Western, Southern- and Northern-Blotting, antibody staining, in situ hybridization, inverse PCR, preparation of nucleic acids and DNA cloning under supervision.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures

and the practical course; (2) Competence area Application of acquired knowledge (30% of grade): Evaluation of the practical course protocol
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular participation (3) The experiments carried out must be described completely and correctly in terms of content in the form of a protocol (competence area 'application of acquired knowledge').
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V416	V416 - Transkriptionskontrolle in Vertebraten V416 - Transcriptional Control in Vertebrates		
Coordinator (responsible lecturer) Prof. Dr. Judith Haendeler (juhae001@hhu.de), PD Dr. Joachim Altschmied (joalt001@hhu.de)			**Status:** 06.07.2018
Lecturers PD Dr. Joachim Altschmied, Prof. Dr. Judith Haendeler, Dr. Niloofar Ale-Agha, Dr. Nadine Dyballa-Rukes, Dr. Karin Aufenvenne, Christine Goy			**Semester:** 5. – 6.
Contact and organization PD Dr. Joachim Altschmied (Joachim.Altschmied@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 6	**Duration** 1 semester
Learning outcomes/skills In this module the basics of transcriptional control in vertebrates as well as a selection of experimental techniques will be developed. The aim is to teach the participants theoretical and practical basic knowledge in this field as well as specific working techniques. Due to the small number of participants an intensive supervision is guaranteed. After successful completion of the module, students will be able to explain the basics of transcriptional control in vertebrates. In addition, they can apply the experimental techniques learned in the module to the analysis of transcriptional regulation in vertebrates and evaluate and discuss the data collected. Based on the techniques presented in the lecture, they are also able to describe further experimental approaches and to select suitable methods for clarifying specific questions in the context of the module topic. The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context. Students are able to plan and prepare a presentation for a target group on a given topic of the module and to present it to a group in English.			
Forms of teaching Practical course -accompanying lecture Practical course with independent experiment execution in groups of two/threes Seminar presentation (Powerpoint presentation)			

Content

The expression of specific genes plays a central role in the expression of cellular properties and the reaction of cells to external signals. It is largely regulated at the transcriptional level. In this module basic mechanisms of transcription regulation in vertebrates are discussed and experiments with state-of-the-art methods are performed.

Lecture:

The practical course will be accompanied by a daily lecture of about one hour, in which the theoretical background (regulatory DNA sequences: promoters, enhancers, transcription factors...) will be discussed: structure, regulation, signal transduction from the cell surface to the cell nucleus, chromatin structure) and on the other hand techniques for the analysis of transcription-regulatory processes in vertebrates and the molecules involved.

Practical course:

In the practical part, which is carried out in groups of two or three, an excerpt from the theoretically discussed method spectrum is taught. During one week the sequence-specific DNA binding of transcription factors will be detected by transfection of reporter constructs into a mammalian cell line and subsequent analysis of the expression of the reporter gene in an enzymatic assay. In the second section, the translocation of a transcription factor activated by an external stimulus from the cytoplasm into the cell nucleus is investigated by fluorescence microscopy. In parallel, the protein is biochemically detected after fractionation of a cell lysate in cytoplasmic and nuclear parts in a western blot.
The performance of the practical experiments must be documented in a protocol, which must be submitted within 3 weeks after the end of the practical experiments.

Seminar:

In addition, each participant must present a partial aspect of the topic in a seminar presentation (Powerpoint presentation) in English; the topics and selected literature will be handed out by the teaching staff in good time before the start of the module.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed, proof of this (submission of transcripts) must be provided in good time before the start of the module.

Content-related: Basic knowledge of DNA and protein structure, transcription and translation is required.

Examination types

Learning portfolio consisting of:

(1) skill area knowledge (50% of grade): final oral examination about the content of the lectures and the practical course;
(2) skill area documentation (25% of grade): written protocol with results and discussion;
(3) skill area scientific presentation (25% of grade): preparation and presentation of a subject related publication/seminar.

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge
(2) Regular and active participation (lectures and practical course, maximum 1 day absent)
(3) Timely submission (3 weeks after the end of the practical course) of a protocol that satisfies the requirements of scientific documentation
(4) Giving a scientific presentation

Relevant for following study programs/major

Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V418	V418 - Genetische und molekulare Prinzipien bei Mikroorganismen
	V418 - Genetic and Molecular Principles of Microorganisms

Coordinator (responsible lecturer) Prof. Dr. Johannes H. Hegemann (johannes.hegemann@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Johannes H. Hegemann (johannes.hegemann@uni-duesseldorf.de)			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Johannes H. Hegemann (johannes.hegemann@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 18	**Duration** 1 semester

Learning outcomes/skills

Students will be able to describe and explain basic genetic and molecular principles of cell biological processes in yeasts and pathogenic bacteria. They can conduct simple genetic, biochemical and molecular biological experiments under guidance based on a practical course script. Students will be able to work independently and properly with the basic measuring instruments and apparatus from the laboratory and explain their underlying theory. The students document the experiments and results in a protocol and evaluate them. The students develop and hold a seminar presentation. The students are able to plan, create and present a target group-oriented presentation on a given topic of the module.

Forms of teaching

Lecture, practical course, Seminar

Content

Lecture:

(1) Basic concepts of the genomes of eukaryotic and prokaryotic microorganisms. Biology of circular and linear chromosomes. Basics of cell division in single-cell organisms. Cell cycle

regulation with cyclins and cyclin-dependent kinases. Forward genetics (generation of and work with mutants + phenotypes); reverse genetics (gene destruction via homologous recombination).
(2) Cell types in yeasts. Mating type and mating type change in yeasts. Molecular switching processes at the mating type locus. Regulation mechanisms of cell type-specific gene groups (mating type a and α; haploid; diploid). Structure of Eu- and heterochromatin.
(3) Cell-cell communication using yeast pairing as an example. The signalling pathway from the secreted hormone to gene regulation in the cell nucleus. Trimeric G proteins. MAP kinase cascade. Plasmogamy, karyogamy.
(4) Pathogenicity mechanisms in bacteria. Bacterial surface structures and their function. Endo- and exotoxins: cytotoxic toxins. A-B toxins. Superantigens. Genome aspects of pathogenicity: pathogenicity islands, virulence plasmids. Type III secretion apparatus. Pathogenicity factors. Adhesion and internalization. Intracellular developmental principles of pathogens. Chlamydial infection cycle.

Practical course:
(1) Morphological + genetic characterization of cell cycle mutants.
(2) Promotor studies with GFP as expression reporter in yeast.
(3) Cloning of a gene by PCR and homologous recombination in yeast.
(4) Protein expression in and affinity purification from bacteria.
(5) Protein-protein interaction analyses using yeast 2-hybrid.

Seminar:
Lecture series on various experimental methods and their theory in modern biology.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (15% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (15% of grade): preparation, presentation and discussion of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language

☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V419	V419 – Grundlagen der Genomanalyse V419 - Fundamentals of Genome Analysis		
Coordinator (responsible lecturer) Prof. Dr. William Martin (bill@hhu.de)			**Status:** 06.07.2018
Lecturers Prof. Dr. William Martin, Dr. Nicole Grünheit			**Semester:** 5. – 6.
Contact and organization Dr. Nicole Grünheit (nicole.gruenheit@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every winter-term	**Group size** 32	**Duration** 1 semester

Learning outcomes/skills
Students can name common programs for dealing with molecular sequence data and describe how they work. They can retrieve and interpret information from biological databases. Students can apply different programs for phylogenetic analysis to sequence data and comment on the results.

Forms of teaching
Lecture or seminaristic lecture with practical exercises

Content
Working with the Linux operating system and the command line.
Retrieving information from biological databases.
Operation of programs for the analysis of sequence data such as ClustalW, PHYLIP, PhyML and EMBOSS.

Further information is available at the following website:

www.molevol.hhu.de/unsere-lehre/bioinformatik/v-modul-419-grundlagen-der-genomanalyse-ss.html

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (50% of grade): written examination about the content of the lectures and the practical course (on the last day of the practical course);
(2) skill area Application of the acquired knowledge (50% of the grade): Query, completion of practical tasks (on the last day of the practical course)

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation
(3) Pass written examination of skill area Application of the acquired knowledge

Relevant for following study programs/major

Bachelor Biologie
Compatibility with other curricula Bachelor computer science
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V421

V421 - Datenauswertung und Datendarstellung

V421 - Data Evaluation and Data Illustration

Coordinator (responsible lecturer) Prof. Dr. Gerhard Steger (steger@biophys.uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Gerhard Steger			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Gerhard Steger (steger@biophys.uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

From a given mathematical equation with a biophysical background, students can deduce important points of the curve (e.g. extremes and limits). The students can graphically display given measurement data in a publication-ready form, fit the measurement data with a given function and extract the obtained parameters from it. The students can present their own measurement data in such a way that the illustrations are suitable for a written work (e.g. Bachelor's or Master's thesis, publication), a presentation or a poster.

Forms of teaching

Lecture with practical exercises, presentation of exercise solutions

Content

Illustrations ready for publication:

Publishing regulations; knitting weights, line types, symbols, font families, font sizes, colors (RGB, CMYK, HSV), color selection (consideration of color blindness, "corporate design"), resolution, units of measurement, graphic formats (PS, EPS, PDF, PNG, JPEG, TIFF)

GLE Graphics Layout Engine:

Creation of publishable images based on measurement data; function plot, histogram, bar chart, etc.

GIMP GNU Image Manipulation Program:

Raster graphics, color overlay

Differential calculus:

difference quotient, slope triangle; derivative, derivative rules, multiple derivatives; curve discussion; partial derivatives; Taylor series; Newtonian approximation

Determination of coefficients:

Matrix calculation; solution of a general inhomogeneous equation system

Statistics:

Random variables; error propagation; correlation coefficient; z-score; median, quantiles

Curve fits:

Combination of curve discussion, Newtonian approximation and solution of an equation system

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Basic knowledge of mathematics is required
Examination types Learning portfolio consisting of: (1) skill area knowledge (80% of grade): written examination about the contents of the lecture and the practical course (presentation and evaluation of measurement data); (2) skill area scientific presentation (20% of grade): Elaboration and presentation of a practice task.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical course) (3) Presentation of one or more exercises
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☒ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V422	V422 - Photo-oxidativer Stress in Pflanzen V422 - Photo-oxidative Stress in Plants		
Coordinator (responsible lecturer) Prof. Dr. Peter Jahns (pjahns@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Peter Jahns			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Peter Jahns (pjahns@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students will be able to describe and explain the basic mechanisms and physiological processes associated with photo-oxidative stress. They will be able to use different analytical methods (e.g. chlorophyll fluorescence spectroscopy, photometry, HPLC) to characterize photo-oxidative stress in plants. The students learn different analytical methods and the independent use of different measuring instruments from the laboratory. They can use what they have learned to assess the sensitivity of plants to light stress and the importance of photoprotective mechanisms. Students will be able to work on the basis of primary literature and overview articles to acquire the basics of a current research topic and get to know a wide range of modern experimental working methods. They are able to interpret the presented experimental results and compare them with other research results to assess the current state of knowledge and the central questions. The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context. The students are able to plan, prepare and present a target group-oriented presentation on a given topic of the module.

Forms of teaching

Lectures, practical course, preparation of presentations and protocol, presentations

Content

Lecture:

Introduction to the stress concept (basic concepts, stress tolerance, stress avoidance, acclimatization, adaptation); soil properties; minerals, basic principles of photosynthesis: structure of photosytsems, light collection and energy dissipation; overview of biotic and abiotic stress factors; light stress: Variations in light supply, sun and shade plants, light effect curve, reactive oxygen species (formation and reactions with biomolecules), plant antioxidants (ascorbate, tocopherol, glutathione), methods for the analysis of photo-oxidative stress (determination of lipid peroxidation, energy dissipation; water stress: Physical and chemical properties of water, water potential, water availability and soil, physiological changes under water deficiency, role of abscisic acid (synthesis, signal transduction, receptors), excess water (stagnant moisture, adaptation strategies); temperature stress: fluctuations of temperature, activation energy and Arrhenius diagram, temperature and membrane

properties, heat stress, heat shock proteins, cold stress and cold damage, temperature sensors and signal pathways, frost stress and ice formation
Practical course:
Quantification of antioxidants (ascorbate, glutathione, tocopherol, carotenoids); Characterization of heat dissipation of excitation energy in plants (chlorophyll fluorescence analysis to quantify energy dissipation and photosynthesis), temperature dependence of photosynthetic electron transport and energy dissipation, photo-oxidative stress and photoinhibition of photosystem II, regulation of photosynthetic electron transport (pH and temperature), separation and quantification of carotenoids.

Seminar:
Current literature on plant stress physiology with a focus on water, temperature and light stress. It describes, applies and explains various molecular, biochemical, physiological and biophysical methods.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (10% of grade): preparation and presentation of a subject related seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation in the practical exercises
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
Lecture notes and accompanying literature are made available via the ILIAS portal. The accompanying seminar can only be attended as part of the module.

V423	V423 - Molekulare Biophysik: Röntgenstrukturanalyse V423 - Molecular Biophysics: X-ray Structure Analysis

Coordinator (responsible lecturer) PD Dr. Joachim Granzin (j.granzin@fz-juelich.de)			**Status:** 01.10.2018
Lecturers PD Dr. Renu Batra-Safferling, PD Dr. Oliver H. Weiergräber, Pd Dr. Joachim Granzin, Prof. Dr. Jörg Labahn			**Semester:** 5. – 6.
Contact and organization PD Dr. Joachim Granzin (j.granzin@fz-juelich.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 8	**Duration** 1 semester

Learning outcomes/skills

The module will provide basic knowledge in X-ray structure analysis so that students will be able to understand and appropriately assess publications on protein structure and function in context.
Students will be able to document the experiments in the form of a protocol, interpret the results and place them in an overall context.
The students are able to plan and create a target group-oriented presentation on a given topic of structural biology and to present it to a group.

In detail, the following competencies are acquired: crystallization of proteins; microscopic methods; X-ray diffraction; data evaluation; phase determination technique; electron density map generation and interpretation; model construction; evaluation of protein structures; interpretation of the 3-dimensional structure in relation to function (e.g. enzyme catalysis and protein-protein interaction).

Forms of teaching

Lecture/seminar with exercises, practical exercises: at the crystallization robot, at the polarization microscope and at the X-ray diffractometer, computer-aided data evaluation

Content

Lecture and practical course:
Practical course (T: **lecture**, P: **practical work**):
1. general crystallography (70%T, 30%P), details: crystal symmetry, crystal optics, polarization microscopy, application of Bragg's law, reciprocal lattice, Ewald construction, symmetry elements, point group, Laue group, space group.
2. crystallization of proteins (50%T, 50%P), Details: crystallization methods, microscopy (polarization and fluorescence).
3. measurement of diffraction data (100%P), details: X-ray sources, detectors, determination of elementary cell and space group, data acquisition.

4th phase determination (50%T, 50%P), Details: Molecular replacement and isomorphic replacement (Patterson methods), Heavy atom derivatives.
5. creation of an atomic model (30%T, 70%P), details: interpretation of an electron density distribution and model construction.
6. refinement, reliability of the model, architecture of the proteins (50%T, 50%P), Details: improvement of the agreement of the atomic model with the diffraction data, R-factor, Ramachandran plot, primary, secondary, tertiary and quaternary structure;
7. structure and function (100%T).

Seminar:
Selected current publications in English on structural biology.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Interest in structural biology, basic mathematical knowledge

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (60% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (20% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, presentation, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
The module takes place at Forschungszentrum Jülich (a shuttle bus runs between the campus of HHU Düsseldorf and FZ Jülich).

V425	V425 - Molekulare Biophysik: Hydrodynamik V425 - Molecular Biophysics: Hydrodynamics		
Coordinator (responsible lecturer) Prof. Dr. Dieter Willbold (willbold@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Dr. Oliver Bannach, Prof. Dr. Gerhard Steger			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Gerhard Steger (steger@biophys.uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students will learn basic physical methods for the analysis of biological macromolecules (centrifugation techniques: sedimentation velocity run, density gradient). Sucrose gradient; gel electrophoresis: PAGE, agarose, SDS; fluorescence correlation spectroscopy). They are able to explain the underlying principles of the methods applied in the practical course, i.e. they are able to explain the applied physical laws.

With the help of the acquired knowledge the students are able to evaluate the learned methods with regard to their applicability to certain biological questions, to compare advantages and disadvantages and to interpret measurement results critically.

The students are able to work independently and precisely with measuring instruments and apparatus from the laboratory. They have learned to prepare samples for biophysical measurements taking into account the respective requirements, to record the measurement data in the required quality and quantity adapted to the typical requirements of the device and to evaluate and graphically display them using the software provided.

They can interpret the results obtained with regard to their significance, accuracy and in larger contexts. The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context.

The students are able to transfer these acquired skills to new scientific questions, i.e. to plan and carry out biophysical experiments independently and to interpret the results critically. The students are able to plan, create and present a target-group oriented presentation on a given topic of the module.

Forms of teaching

Lecture, practical course, Seminar

Content

Lecture:

Molecular structures: primary, secondary, tertiary structure of proteins; super-secondary structures, protein folding, molecular packing; primary, secondary, tertiary structure of nucleic acids.

Size and shape of macromolecules: hydration, Stokes radius; conformation
Macromolecular diffusion: Fick's diffusion laws, measurement of diffusion coefficients
Hydrodynamics: viscosity of macromolecular solutions, coefficients of friction, shape

Practical course:
Hydrodynamic methods and their application to proteins and nucleic acids: preparative and analytical ultracentrifugation, fluorescence correlation spectroscopy, gel electrophoresis

Seminar:
Selected original works from the field of hydrodynamics

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Computation, physics for scientists, basic knowledge of the structure of biological macromolecules

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (60% of grade): oral examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (20% of grade): preparation, presentation and discussion of a subject related seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☒ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V426	V426 - Grundlagen der Mikrobiologie und Enzymtechnologie V426 - Basic Principles in Microbiology and Enzyme technology

Coordinator (responsible lecturer) Prof. Dr Karl-Erich Jaeger (k.-e.jaeger@fz-juelich.de)			**Status:** 06.07.2018
Lecturers Prof. Dr. Jaeger, Institute of Molecular Enzyme Technology Dr. Krauss, Institute of Molecular Enzyme Technology Dr. Knapp, Institute of Molecular Enzyme Technology Prof. Dr. Pohl, Institute for Bio- and Geosciences IBG-1: Biotechnology, Research Centre Jülich GmbH			**Semester:** 5. – 6.
Contact and organization Dr. Krauss (u.krauss(at)fz-juelich.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every winter-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills
Students can describe the basic concepts of a molecular biological and protein chemical experiment. They can evaluate and assess the results of the experiments and explain influencing factors in some experiments.
Students will be able to identify the basic molecular processes of protein production and transfer them to biotechnological experiments.
They can solve basic tasks in this field independently and handle some laboratory equipment independently.

Forms of teaching
Lecture with practical exercises/discussion, practical course, preparation of final papers with presentation, group work, protocol writing

Content
Lecture and practical course:
Basics of microbiology, growth and reproduction of bacteria, basics of molecular biology such as plasmid structure and cloning. Expression (heterologous overexpression), function and purification of proteins, enzyme tests, methods for protein analysis, biotechnological applications of enzymes, enzyme/protein analytics such as kinetic determination and stability studies, use of literature and sequence databases.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basics of microbiology and molecular biology should be known, basic

knowledge in mathematics is required.

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination.
(2) skill area documentation (30% of grade): written protocol

Requirements for the award of credit points for this course

Regular active participation, presentation of results, submission of a scientifically acceptable protocol.

Relevant for following study programs/major

Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula

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Significance of the mark for the overall grade

The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language

☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information

Registration via LSF https://lsf.uni-duesseldorf.de/

The module takes place at the Institute of Molecular Enzyme Technology (IMET) on the campus of Forschungszentrum Jülich in Jülich. After allocation, feedback to Dr. Krauss via e-mail is mandatory.

V427	V427 - Methoden der Zellfraktionierung und Proteomanalyse V427 - Methods in Cell Fractionation and Proteome Analysis

Coordinator (responsible lecturer) Prof. Dr. William Martin (bill@hhu.de)			**Status:** 06.07.2018
Lecturers Prof. Dr. William Martin, Dr. Verena Zimorski			**Semester:** 5. – 6.
Contact and organization Dr. Verena Zimorski (zimorski@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every winter-term	**Group size** 18	**Duration** 1 semester

Learning outcomes/skills

The students can independently plan, apply and critically interpret the basic methods of cell disruption, centrifugation techniques, sample preparation and performance of various 2D electrophoresis techniques, as well as explain, analyze and evaluate the basics of protein sequencing using mass spectrometry. In addition, they will be able to apply standard protein biochemical methods such as enzyme assays, protein concentration determination, various protein staining methods in acrylamide gel and detection of proteins in Western blot, independently and precisely plan and perform. Students can document the experiments in the form of a protocol, interpret the results and place them in an overall context.

Forms of teaching

Lecture with practical exercises in the laboratory

Content

Difference genomics and proteomics.
Information content of genomes and proteomes.
Properties of proteins.
Posttranslational modifications.
Techniques of proteome analysis such as separation of complex protein mixtures and mass spectrometric identification of proteins.
Detection of modifications.
Opportunities and limitations of proteome analysis.
Application of protein biochemical research methods.

Further information is available at the following Internet address:
http://www.molevol.hhu.de/unsere-lehre/biochemie/v-modul-427-methoden-der-zellfraktionierung-und-proteomanalyse-ws.html

Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** None
Examination types Learning portfolio consisting of: (1) skill area knowledge (50% of grade): written examination about the content of the lectures and the practical course; (2) skill area documentation (50% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (3) Punctual submission of scientific protocol (4) Participation in the preliminary discussion
Relevant for following study programs/major Bachelor Biologie
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V428	V428 - NMR-Spektroskopie biologischer Makromoleküle V428 - NMR Spectroscopy of Biological Macromolecules

Coordinator (responsible lecturer) Prof. Dr. Dieter Willbold (dieter.willbold@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Dr. Matthias Stoldt			**Semester:** 5. – 6.
Contact and organization Dr. Matthias Stoldt (m.stoldt@fz-juelich.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students will be able to explain the basic concepts of liquid NMR spectroscopy and its applications in structural biology. They can explain how structural information can be obtained from biological systems focused on proteins. They can assess the method in such a way that they know the requirements for the samples (proteins), the strengths and limitations and the comparability with other biophysical methods. The students are able to interpret one- and multidimensional spectra with different information content (chemical structure, secondary structure, tertiary structure, ligand binding) and to independently determine the information relevant for the respective question. Furthermore, they are able to question their results and check them with the help of databases (protein-3D structures, biological NMR database). The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context.

The students are able to plan, create and present a target-group oriented presentation on a given topic of the module in front of a group.

Forms of teaching

practical exercises at the NMR spectrometer, seminaristic lecture, exercises for software-based data evaluation, protocol writing

Content

General basics of NMR spectroscopy, application of NMR spectroscopy in biological questions. Spin quantum numbers, energy levels, occupation ratios, chemical shift, FT-NMR, 1-D experiment, line shape, relaxation, Fourier transformation, spectral parameters, indirect coupling, structure of an NMR spectrometer.

Recording of 1D experiments (ethanol, amino acids, proteins), processing and evaluation of spectra. From 1D to 2D experiments, principle of indirect dimension, homonuclear and

heteronuclear experiments.
Basics of triple resonance experiments, recording, processing, classification strategy (example: HNCACB), backbone classification, classification of 3D NOE spectra, extraction of structure-determining parameters.
Molecular dynamics, strategy of "simulated annealing", experimental data for structure calculation, example structure calculation, quality parameters, advanced methods, further applications of NMR in biology.
Visualization of protein and RNA structures & complexes, secondary structure, hydrophobic core, tertiary contacts, electrostatic potential.

Seminar:
Selected current publications on structural biology and NMR methodology.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Interest in structural biology and spectroscopy, basic mathematical and physical knowledge

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (60% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (20% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, presentation, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
The module takes place at Forschungszentrum Jülich (a shuttle bus runs between the campus of HHU Düsseldorf and FZ Jülich).

V429	V429 - PC gestützte Analyse und Präsentation biologischer Daten V429 - PC Based Analysis and Presentation of biological Data		
Coordinator (responsible lecturer) Prof. Dr. Andreas Weber (andreas.weber@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Andreas Weber, Dr. Marion Eisenhut			**Semester:** 5. – 6.
Contact and organization Dr. Marion Eisenhut (m.eisenhut@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

The students can recognize the data types of biological experiments and can analyze and display them with descriptive as well as with conclusive statistics. They master statistically correct experimental design. Students can analyze biological data with linear and non-linear regression and interpret the results. Students will be able to explain and apply the basics of exploratory statistics. Students will be familiar with a spreadsheet program as well as the analysis programs Graph-Pad Prism and Open-Source clustering programs.

Forms of teaching

Lecture and independent practical exercises on the computer

Content

Lecture:

In the first part, the different data types are described using examples and their presentation is explained. Different methods of descriptive and closing statistics for the different data types are shown. The second part lays the foundations for linear and non-linear regression. Different non-linear models are explained and applied. Statistical methods for the evaluation of non-linear regression are presented.
Probability calculation is introduced as far as necessary for the evaluation of data.
In explorative statistics, non-supervised methods such as clustering are discussed and their visualization shown.

Exercises:

The theoretical basics are taught daily in the lecture before the exercises. In the exercises the theoretical basics are deepened by application. For each topic of the lecture, one or more

sample data sets are processed, analyzed and presented on the computer in a spreadsheet program and in the GraphPad Prism program. The explorative statistics are practiced with the help of cluster programs and visualizations.
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Basics of spreadsheet programs, basic mathematical understanding
Examination types Learning portfolio consisting of: (1) skill area knowledge (60% of grade): written examination (2) skill area exercises (40% of grade)
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (lectures and exercises) (3) Daily submission of the exercises, which were processed according to the minimum standards
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ Place and time are announced in the LSF. Lecture scripts and exercises are made available via the Ilias portal.

V430	V430 - Pflanzliche Genetik und Biochemie V430 - Plant Biochemical Genetics		
Coordinator (responsible lecturer) Prof. Dr. Andreas Weber (andreas.weber@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Andreas Weber, Dr. Nicole Linka			**Semester:** 5. – 6.
Contact and organization Dr. Nicole Linka (nicole.linka@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

Students will be able to describe, apply and analyse the basic concepts and methods of plant genetics and biochemistry.
Students can independently carry out and plan simple molecular biological and biochemical experiments/techniques. Students also learn how to document scientific investigations and how to record experiments and the results obtained. Students will be able to plan, create and present a target group-oriented presentation on a given topic of the module.

Forms of teaching

Lecture, Practical course and Seminar

Content

Lecture:
Students are familiarized with the central carbon and storage metabolism of plants. Furthermore, they learn the theoretical basics of the analysis of central plant metabolic pathways by a combination of genetic and biochemical methods.

Practical course:
The aim of the practical course is to characterize different Arabidopsis mutants with defects in the central storage metabolism using a series of molecular biological and biochemical methods. This includes the quantitative and qualitative analysis of metabolites (different sugars, starch), proteins (protein gel electrophoresis), enzyme activities and enzyme kinetics (different enzymes of the central carbon metabolism, spectrophotometric tests and native gels) as well as molecular genetic investigations on the mutants (identification of mutant alleles and transient transformation for complementation of plant mutants).

Seminar:

Literature seminar of the students about classical and current original papers with thematic reference to the topics of the lecture and the practical course.
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Basic knowledge of plant physiology and genetics
Examination types Learning portfolio consisting of: (1) skill area knowledge (50% of grade): written examination about the content of the lectures and the practical course; (2) skill area documentation (30% of grade): written protocol (3) skill area scientific presentation (20% of grade): Elaboration of a presentation in English.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (lectures and practical course) (3) Punctual submission of scientific protocol (4) Giving a scientific presentation in English
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ Place and time are announced in the LSF. Lecture notes and accompanying literature will be made available via the Ilias Portal.

V431	V431 - Festkörper-NMR-Spektroskopie in der Strukturbiologie V431 - Solid-State NMR-Spectroscopy in Structural Biology		
Coordinator (responsible lecturer) Prof. Dr. Henrike Heise (h.heise@fz-juelich.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Henrike Heise			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Henrike Heise (h.heise@fz-juelich.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students will be able to explain the basic concepts of solid state NMR spectroscopy and its applications in structural biology ("what does "solid" mean in biological systems?). They can explain how structural information cannot be obtained from biological systems for solution NMR spectroscopy and X-ray crystallography, such as membrane proteins in physiological environments or fibrillar protein aggregates. The students are able to interpret one-dimensional and multidimensional spectra with different information content (secondary structure, orientation, mobility) and independently determine the information relevant for the respective problem. Furthermore, they are able to question their results and check them with the help of computer simulations.

Forms of teaching

practical exercises at the NMR spectrometer, seminaristic lectures, exercises for software-based data evaluation, computer simulations, protocol writing

Content

General principles of solid-state NMR spectroscopy, problems that can be solved with this method, various methods to achieve high resolution despite anisotropic line widening: Magic Angle Spinning and macroscopic orientation. Structural information in solids: torsion angle, dipolar couplings and chemical shift anisotropy. Simulation software: SIMPSON and MATLAB, analysis software: nmrPipe, nmrDraw, CCPN.
Investigation objects: single amino acids in solid phase and smaller model peptides.

Seminar:
Selected current publications on solid state NMR spectroscopy in structural biology.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed

Content-related: Basic knowledge in physical chemistry and basics of biochemistry are required. Interest in structural biology and physico-chemical interrelationships is required.

Examination types

Learning portfolio consisting of:

(1) skill area knowledge (60% of grade): written examination about the content of the lectures and the practical course;

(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;

(3) skill area scientific presentation (20% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge

(2) Regular and active participation (practical course)

(3) Punctual submission of scientific protocol

(4) Giving a scientific presentation

Relevant for following study programs/major

Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula

Bachelor Biochemistry

Significance of the mark for the overall grade

The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language

☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information

Registration via LSF https://lsf.uni-duesseldorf.de/

The module takes place at Forschungszentrum Jülich (there is a shuttle bus between the campus of HHU Düsseldorf and FZ Jülich).

V433	V433 - Programmieren für Biologen V433 - Programming for Biologists

Coordinator (responsible lecturer) Prof. Dr. William Martin (bill@hhu.de)			**Status:** 06.07.2018
Lecturers Summer semester: Prof. Dr. William Martin, Dr. Nicole Grünheit Winter semester: Prof. Dr. William Martin, Prof. Dr. Martin Lercher, Dr. Nicole Grünheit, Dr. Mayo Röttger			**Semester:** 5. – 6.
Contact and organization Summer semester: Dr. Nicole Grünheit (nicole.gruenheit@hhu.de) Winter semester: Dr. Mayo Röttger (mayo.roettger@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** Summer-term: 20 Winter-term: 40	**Duration** 1 semester

Learning outcomes/skills

The students have learned the basic principles of programming. They will be able to use the programming language Python in a practice-oriented way and design algorithms independently, implement them and automate complex workflows. They are able to process large amounts of biological data. Students can develop different solutions and comment critically.

Forms of teaching

Lecture or seminaristic lecture with practical exercises

Content

- Introduction to the programming language Python (syntax, data structures, control structures, statement logic, reading and writing files)
- Introduction to the Linux operating system and the command line
- The course is specifically designed to meet the needs of biology students who have no programming experience.
- Both theoretical background information and practical skills are taught. Students perform practical exercises and discuss the results.

Further information is available at the following website:

http://www.molevol.hhu.de/unsere-lehre/bioinformatik/v-modul-433-prgrammieren-fuer-biologen-wintersemester.html

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types

Learning portfolio consisting of:

(1) skill area knowledge (50% of grade): written examination (with practical parts) about the content of the lectures and the practical course; (2) skill area Application of the acquired knowledge (50% of grade): Exercise tasks, submission of exercise sheets
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (3) Pass written examination of skill area Application of the acquired knowledge
Relevant for following study programs/major Bachelor Biologie
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V434	V434 - Zellbiologie und Physiologie
	V434 - Cell Biology and Physiology

Coordinator (responsible lecturer) Prof. Dr. Eckhard Lammert (lammert@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Eckhard Lammert and employees			**Semester:** 5. – 6.
Contact and organization Dr. Daniel Eberhard (daniel.eberhard@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** 2x every winter-term (Group a and b)	**Group size** 30 (2x15)	**Duration** 1 semester

Learning outcomes/skills

Students can describe, apply and analyse the basic concepts of nutrition and digestion, respiration, excretion, glucose metabolism, hormone secretion and cell growth. Students can independently perform and plan basic laboratory techniques and experiments in physiology and cell biology. Students can work independently and precisely with pipettes, photometers, sterile workbenches, incubators, PCR machines and fluorescence light microscopes. The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context.
Students will be able to plan and prepare a presentation on a given topic of the module and present it to a group.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:
General Basics of Cell Biology and Physiology of Humans and Mice as Model Organisms

Practical course:
Application of physiological and cell biological research methods for the analysis of excretion, glucose metabolism, cell growth, gene expression and hormone secretion of the animal organism, e.g. determination of concentrations by photometer; splitting, culturing, counting and freezing of cells; extraction of RNA; production of cDNA; RT-PCR; localization of proteins in cells; enzyme kinetics; statistics; independent design of some experiments.

Seminar:
The students will give a presentation on different topics of cell biology and physiology and discuss them with the lecturers and students.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Reading the script
Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course; (2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment; (3) skill area scientific presentation (10% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical course) (3) Punctual submission of scientific protocol (4) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V435

V435 - Analyse von Proteinwechselwirkungen mit NMR-Spektroskopie

V435 - Analysis of Protein Interactions by NMR Spectroscopy

Coordinator (responsible lecturer) PD Dr. Bernd König (b.koenig@fz-juelich.de)			**Status:** 06.07.2018
Lecturers PD Dr. Bernd König, Dr. Philipp Neudecker, Dr. Silke Hoffmann			**Semester:** 5. – 6.
Contact and organization PD Dr. Bernd König (b.koenig@fz-juelich.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 6	**Duration** 1 semester

Learning outcomes/skills

The students can explain the basic concepts of solution NMR spectroscopy, the basic structure of a high-field NMR spectrometer and the application possibilities of NMR in biology. They can independently record, process and analyze NMR spectra. The students are able to plan, perform, evaluate and interpret NMR titration for the study of the binding of a ligand to a protein. They can calculate protein structures from experimental data, display them graphically on the computer and highlight the binding site found. The students precisely document the experiments carried out, evaluate them and discuss the results. They can work on a given topic using English technical literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

(1) Biological background: Interaction of HIV-1 Nef with SH3 domains.
(2) General basics of NMR spectroscopy: Pulsed Fourier transform spectroscopy, one- and multidimensional NMR spectroscopy, experimentally determined parameters (chemical shift, scalar coupling, dipolar coupling, Kern-Overhauser effect - NOE), high-field NMR spectrometer (setup).
(3) NMR on biomacromolecules: isotope labeling and recombinant production, proteins as biopolymers, accessible information (structure, dynamics, interactions).
(4) Strategies for data evaluation: resonance allocation, determination of geometric parameters, molecular dynamic structure calculation.
(5) Analysis of protein-ligand interaction by NMR: HSQC titration, localization of binding sites,

exchange regime, quantitative evaluation (mass action law, binding models, determination of bound ligand fraction).

Seminar:
The basics of NMR spectroscopy (vector model, FT NMR, pulse sequences, relaxation) and relevant NMR parameters (chemical shift, scalar coupling, NOE) will be presented and deepened in exercises. Each participant gives a presentation on a selected aspect of solution NMR spectroscopy based on English literature.

Practical course:
Sample preparation (dialysis, concentration determination, pH value adjustment), recording of one- and multidimensional NMR spectra; spectra processing and analysis (with the software nmrPipe) and visualization (nmrDraw); resonance assignment using 2D and 3D NMR spectra (CARA); performance of two NMR-based titrations of the 15N-labelled protein domain Hck-SH3 with the ligands (a) Nef peptide and (b) Nef core protein: Sample preparation, spectra acquisition and evaluation; quantitative evaluation of a titration series: iterative assignment of HSQC spectra, determination of data points for the binding isotherm, adaptation of data to a suitable binding model (QtiPlot) and determination of dissociation constants; Calculation of the high-resolution spatial structure of the Hck-SH3 domain based on existing experimental structural data (NOE-based list of proton-proton distances in the folded protein) using molecular dynamics (CYANA); visualization and evaluation of the calculated protein structures (MOLMOL); representation of the binding site of the nef-peptide on the surface of the structure of the Hck-SH3 domain

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Biochemical bases for the construction of proteins and amino acids as well as the concepts of physical chemistry for the description of the thermodynamic equilibrium are presupposed.

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): oral examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (10% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ The module takes place at Forschungszentrum Jülich (there is a shuttle bus between HHU Düsseldorf and FZ Jülich). Literature: Chapter „Magnetische Resonanzspektroskopie von Biomolekülen“, *in*: F. Lottspeich, J.W. Engels „Bioanalytik“, Spektrum Akad. publishing house, 2006

V436	V436 - Biochromatographie V436 - Biochromatography		
Coordinator (responsible lecturer) Prof. Dr. Georg Groth (georg.groth@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Georg Groth			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Georg Groth (georg.groth@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 12	**Duration** 1 semester

Learning outcomes/skills

Students can develop their own concepts for the purification of biomolecules and independently solve separation problems in the isolation of proteins from cells or cell disruption. They are able to work independently and precisely with complex modern chromatography systems. The students can precisely document and evaluate the experiments carried out. They can independently work out a given topic with the aid of English technical literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

The lecture deals with the isolation, purification and characterization of proteins/enzymes from biological materials using different biochromatography techniques and separation systems.

(1) Recombinant production of proteins
(2) Structure, function and properties of the green fluorescent protein (GFP)
(3) Basics, function and peculiarities of the separation mechanisms, separation materials
(4) Separation mechanisms of biochromatography: SEC (separation by molecular size), IEC (separation by charge), HIC (separation by hydrophobicity), affinity chromatography (separation by biospecificity)
(5) Perfusion chromatography
(6) Covalent chromatography method: Purification of sulfur-containing peptides and metallothioneins
(7) lectin chromatography
(8) Optimal sequence of the different separation systems during protein purification
(9) Chromatographic characteristics: Flow time, retention time, separation factor, capacity factor, number of trays or number of separation stages
(10) Typical problems in the chromatographic separation of biomolecules

Practical course:

The subject of the biochromatography practical course is the separation and purification of the

green fluorescent protein (GFP), which originates from the jellyfish Aequorea victoria and is now used in a variety of applications in modern biochemistry and cell biology. The protein is produced recombinantly in E. coli and purified from the culture supernatants using various chromatographic methods such as size exclusion chromatography, ion exchange chromatography, hydrophobic interaction chromatography (HIC) and affinity chromatography. The separation is performed with modern computer-controlled chromatography systems, which are also used in basic and applied research. Important chromatographic parameters (e.g. selectivity, capacity, soil count, etc.) as well as the development and optimization of chromatographic separation methods are dealt with in the various separation methods.

Seminar:
Based on selected short reports (David S. Goodsell *"Molecule of the Month"*, The Scripps Research Institute and RCSB PDB) as well as selected original and review papers, students will present the structure, function and significance of different biological macromolecules.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic knowledge of general biology, inorganic and organic chemistry as well as mathematics and physics.

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area scientific presentation (30% of grade): preparation, presentation and discussion of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
-

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V440	V440 - Evolution der Pflanzen
	V440 - Plant Evolution

Coordinator (responsible lecturer) Dr. Sabine Etges (etges@hhu.de)			Status: 01.10.2018
Lecturers Dr. Sabine Etges			**Semester:** 5. – 6.
Contact and organization Dr. Sabine Etges (etges@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students can describe and explain evolutive processes that have made land life possible for plants (adaptations in the areas of uptake and transport, energy gain, stability, reproduction, etc.).
They can describe and interpret the functionality of individual plant organs and convergent adaptations. They can assign characteristics of plants to progressive and regressive evolution.
They can describe the development history of plants. They can explain the systematic importance of individual characteristics and their development to representatives of some important kinship groups.
The students are able to plan, create and present a target group-oriented presentation on a given topic of the module in front of a group.

Forms of teaching

Lecture, practical curse, seminar

Content

The theoretical foundations of evolution and systematics are explained, taking into account the historical developments of scientific systematics and the understanding of evolution.
The derivation of land plants (mosses, ferns and seed plants) from green algae is presented in living material. The transition to seed plants is demonstrated with fossil preparations.
The different morphological adaptations of land plants to life outside the water (strengthening elements, secondary thickness growth, water pipe tissue, formation of flowers and inflorescences, double fertilization, etc.) and their evolution are discussed. Examples will be given to illustrate how it is difficult to understand the history of development.
The structure of the system of seed plants is explained and the characteristic development is made clear by representatives of some important orders.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (15% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (15% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
The seminar dates will be arranged during the internship.

V441

V441 - Ökologisch-systematisches Geländepraktikum mit großer Exkursion

V441 - Ecological and systematical field course

Coordinator (responsible lecturer) Dr. Sabine Etges (etges@hhu.de)			**Status:** 01.10.2018
Lecturers Dr. Sabine Etges			**Semester:** 5. – 6.
Contact and organization Dr. Sabine Etges (etges@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 8	**Duration** 1 semester

Learning outcomes/skills

The students can describe and explain ecological relationships. They can independently identify plants unknown to them using digital and analogue identification keys and assign them to their relatives. They can name typical species of the different habitats and their characteristics and describe their adaptation mechanisms. Students will be able to plan, create and present a target group-oriented presentation on a given topic of the module.

Forms of teaching

Lecture, seminar, excursion (Norway or Gotland/Sweden)

Content

The **lecture** deals with the geology of Scandinavia as well as the course of the ice ages and their influence on the landscape. The formation of glaciers and fjords and the changes of the coastlines by land elevations are explained. The climate of Scandinavia is a second focus of the lecture. The distribution of the vegetation zones is derived from the climatic characteristics of the individual regions of Scandinavia and the most important factors for plant distribution will be discussed.
Forest and lawn communities, moors, coastal vegetation, dwarf shrub and lichen heaths as well as glacier forefield and high alpine plant communities in Norway are presented as examples. In Sweden, special attention is paid to the special vegetation of dry heaths (Alvar). Zoological aspects and the history of each country are taken into account.

In a **block seminar** before the excursion the students treat in presentations (20 min.) selected aspects of the structure of the country, the climate and the vegetation, which complement the content of the lecture.

On the **excursion day** tours with demonstrations in the field and subsequent The processing was carried out in the camp. Ecological, vegetation science and systematic aspects. An overview of evolution, diversity, flower biology and Peculiarities of different plant groups are imparted.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the excursion;
(2) skill area documentation (15% of grade): written protocol of the excursion incl. herbarium vouchers of selected plants;
(3) skill area scientific presentation (15% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation On the excursion
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
The module is assigned decentrally.

V446

V446 - Grundlagen der Biodiversität und Evolution

V446 - Foundations of Biodiversity and Evolution

Coordinator (responsible lecturer) Prof. Dr. Werner Kunz (Kunz@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Werner Kunz			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Werner Kunz (Kunz@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

Students can understand the causal and driving forces underlying the theory of evolution.
Students can explain the differences between phenotypic diversity and homologous kinship.
Students can explain the differences between allelic diversity and taxonomic grouping.
Students can combine population genetics with biological systematics.
The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context.
The students are able to plan, create and present a target-group oriented presentation on a given topic of the module in front of a group.

Forms of teaching

Lectures, seminars, practical demonstrations in the field

Content

Lecture and seminar:

Laws of evolution theory; replication, mutation and selection; random principle and the control by selection; the goal concept in evolution; the meaning of overproduction; emergence of diversity; sympatric and allopatric species development; species formation by sexual selection; characteristically oriented class formation; cladistic splitting; monophylia, paraphylia; anagenesis and cladognesis; biparental and uniparental organisms; reproductive connection; Limits of gene flow; the concept of homology; hybridogenic species formation; genetic drift; Hardy-Weinberg Law; morphogenesis by structural genes and regulatory genes; genetic bases of species formation; species-forming genes; the laws of species formation due to environmental factors and genome characteristics; the significance of all frequency distributions in relation to species and race formation; intra-species differences due to stable polymorphisms; causes of species extinction.

Practical course:

Demonstration of intra-species morphs using several butterfly species in the field; demonstration of differences between morphs and breeds using butterfly and bird species as examples; the connection of the third Mendel rule with the occurrence of morphs in Aries Zygaena ephialtes; documentation of parasitism and symbiosis in blue ants in the field; genetic polymorphisms and selection in the ligamentous snail Cepaea; morphs using uni- and bivoltine butterflies as examples.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed

Content-related: Preparation based on PowerPoint presentations on the homepage on the Internet

Examination types

Learning portfolio consisting of:

(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (15% of grade): written protocol with results and discussion;
(3) skill area scientific presentation (15% of grade): short oral presentation of the individual experiments.

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge
(2) Regular and active participation (lectures, practical course and seminar)
(3) Punctual submission of scientific protocol

Relevant for following study programs/major

Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula

-

Significance of the mark for the overall grade

The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language

☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information

Registration by e-mail to Prof. Kunz

V462	V462 - Molekulare Medizinische Immunologie V462 - Molecular and clinical Immunology		
Coordinator (responsible lecturer) Prof. Dr. Markus Uhrberg (uhrberg@itz-uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Markus Uhrberg			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Markus Uhrberg (uhrberg@itz-uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Immunological barriers, natural immunity, initiation and effector phase of an immune response, immune memory, function and signal transduction pathways of the different immune cell types can be explained and the components involved can be named.
The basic immunological mechanisms can be transferred to concrete and clinically relevant examples.
Course participants will be able to perform experimental approaches based on the script. Furthermore, they can perform necessary calculations (concentrations, volumes) and transfer them to changed targets.
The ability to precisely pipette small volumes and to work sterilely in the sterile bank will be acquired.
Basic techniques (e.g. isolation of lymphocytes from peripheral blood) can be performed independently. The principles of various advanced immunological techniques (e.g. HLA typing) can be explained and applied. Measurements on relevant analytical devices (e.g. flow cytometers) can be performed under supervision.
The test results can be analysed, graphically evaluated and formulated in writing. The results obtained can be explained and critically evaluated against the background of the learning material.
The ability to work in a team is promoted through cooperation in small groups (2-4 students).

Forms of teaching

Lecture, practical course, protocol writing

Content

Lecture:
Non-adaptive and adaptive immunity, inflammatory process, T-cell and B-cell diversity, T-cell and B-cell response, tumor immunology, natural killer cells, dendritic cells, KIR receptors, immune receptor signal transduction, transplantation immunology, MHC class I and II, immunological methods.

Practical course:

Immunogenetic determination and functional analysis of human cell lines, primary lymphocytes (T-, B-, and NK-cells) and dendritic cells. Methods: PCR, RT-PCR, HLA class I and II typing, KIR typing, processing of blood samples, proliferation assays, mixed lymphocyte cultures (MLC), transfection of primary lymphocytes, flow cytometry.
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Basic knowledge in genetics and cell biology is required.
Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination; (2) skill area documentation (30% of grade): written protocol
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical exercises) (3) Punctual submission of scientific protocol
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ - Attendance at the preliminary meeting is mandatory. - One CP is awarded for regular participation in the lecture without an associated practical course.

V465	V465 - Stammzellbiologie und Regenerative Medizin V465 - Stem Cell Biology and Regenerative Medicine		
Coordinator (responsible lecturer) PD Dr. Thorsten Trapp (trapp@itz.uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Fischer, Kögler, Rox, Santourlidis, Trapp, Trompeter, Wenzel			**Semester:** 5. – 6.
Contact and organization PD Dr. Thorsten Trapp (trapp@itz.uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** 12	**Duration** 1 semester

Learning outcomes/skills

Students can explain the basic characteristics of stem cells, their origin and their role in tissue regeneration and tumor development. In the practical course, biochemical, cell biological and molecular biological experiments are carried out independently under supervision. The students can explain the theories on which the experiments are based and are qualified to handle the required equipment properly. The students document the experiments in a rule-compliant protocol, evaluate them and discuss them critically.

Forms of teaching

Lecture, practical course

Content

Lectures:

- Fundamentals of Stem Cell Biology
- classification, origin and characteristics of stem cells (embryonic SZ, adult SZ, neonatal SZ, mesenchymal SZ, hematopoietic SZ, tissue SZ)
- Basics of tissue regeneration
- Role of stem cells in tumor biology
- Epigenetics of stem cells
- Transcriptional and post-transcriptional regulation of stem cells / Basics of the biology of microRNAs
- Clinical aspects of stem cell transplantation
- Ethical and legal aspects of stem cell medicine

Practical course:

- Isolation of stem cells from blood
- Cultivation of cells
- Characterization of stem cell migration using agarose invasion and scratch assays
- wound healing assay

- Characterization of stem cell markers using FACS
- Expression analysis of stem cell relevant proteins by Western blot and immuno-cytochemistry (fluorescence microscopy)
- Expression analysis of stem cell relevant genes by PCR
- Osteogenic differentiation of adult stem cells
- Characterization of epigenetic changes in stem cells / analysis of DNA methylation
- Analysis of micro-RNA expression and its effect on post-transcriptional regulation in stem cells

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (30% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
Attendance at the preliminary meeting is mandatory. One CP is awarded for regular participation in the lecture without an associated internship.

V474

V474 - Molekulare Biotechnologie der Pflanzen

V474 - Genomics and Molecular Biology of Plants

Coordinator (responsible lecturer) Prof. Dr. Peter Westhoff (west@hhu.de)			**Status:** 02.07.2018
Lecturers Dr. Karin and others			**Semester:** 5. – 6.
Contact and organization Dr. Karin Ernst (karin.ernst@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

The students can describe and explain basic concepts and methods of molecular biotechnology of plants as well as apply the acquired methodological knowledge in practice. The students can precisely document, evaluate and evaluate the experiments carried out. They can independently work out a given topic with the aid of English technical literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

- Introduction to Crops: Socioeconomics, Occurrence and Origin, Domestication, Genetic Diversity, Objectives and Methods of Plant Breeding.
- Transformation of plants: Biology of Agrobacterium tumefaciens, plant transformation by Agrobacterium, alternative transformation methods.
- Quantitative properties: Definition of quantitative traits (QTL: "quantitative trait locus"), phenotypic variance, objectives and implementation of a QTL analysis (molecular markers, splitting mapping populations, phenotyping, accounting methods for QTL), molecular isolation of QTL, case studies of molecularly characterized QTL, association mapping.
- Plant breeding with transgenic plants: genetic engineering tools (promoters, RNAi methods), yield improvement (e.g. rice), quality breeding (modification of lipid metabolism), resistance breeding (e.g. salt tolerance).

Practical course:

- Analysis of genetic diversity in maize: Amplification of distinct gene loci from different

inbred lines and landraces, DNA sequencing of amplificates, computer-assisted evaluation and comparison of sequences.
- Transient transformation of Nicotiana benthamiana: transformation with Agrobacterium tumefaciens, isolation of mesophyll protoplasts, fluorescence microscopic analysis of the expression of promoter-reporter gene (GFP) constructs.
- Phenotypic effects of drought stress in different maize varieties: Habitus differences in shoot and roots, chlorophyll content, water potential and stomatal conductivity of leaves.
- Influence of nitrate on the physiology and morphology of different maize varieties: Computer-aided analysis of the root architecture of seedlings at different nitrate concentrations, physiology of maize varieties in hydroponic culture (photosynthesis measurements, nitrate accumulation, expression of genes of nitrate assimilation).

Seminar:

Selected original and review papers on history, domestication, socio-economic significance, physiology and genetic modification of cultivated plants.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (10% of grade): preparation, presentation and discussion of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course, seminar)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V482

V482 - Statistische Datenanalyse

V482 - Statistical Data Analysis

Coordinator (responsible lecturer) Oliver Ebenhöh (oliver.ebenhoeh@uni-duesseldorf.de)			**Status:** 23.07.2019
Lecturers Oliver Ebenhöh, Ovidiu Popa			**Semester:** 5. – 6.
Contact and organization Oliver Ebenhöh (oliver.ebenhoeh@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

Students will understand the concepts underlying the various statistical test methods. They can assign the different statistical tests to the problems. Students are familiar with the techniques used to reduce high-dimensional data sets. They can implement the statistical concepts taught in a common programming language (R).

Forms of teaching

Lecture with practical exercises

Content

The lecture covers the basics of statistical data analysis. Students learn not only how to perform statistical tests, but also the limitations of their applicability. The methods of parametric and non-parametric tests are covered in detail, such as permutation tests and correlations in data sets using regression and the assessment of statistical significance. Another focus of the module is the introduction of network-based methods (Bavarian networks and graph theory) to identify and characterize correlations in biological data sets.
The lecture will be accompanied by an introduction to the programming language R (previous knowledge in programming is not required). In the computer exercises the contents of the lecture will be put into practice.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic mathematical knowledge must be available

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the exercises;
(2) skill area Application of knowledge (30% of grade): exercises

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge

(2) Pass 50% of the exercises
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V484	V484 - Phänotypische Anpassung der Pflanzen V484 - Phenotypic Adjustment of Plants		
Coordinator (responsible lecturer) Prof. Dr. Ulrich Schurr (u.schurr@fz-juelich.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Ulrich Schurr, PD Dr. Shizue Matsubara			**Semester:** 5. – 6.
Contact and organization PD Dr. Shizue Matsubara (s.matsubara@fz-juelich.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 12	**Duration** 1 semester

Learning outcomes/skills
Students will be able to explain basic concepts of phenotypic adaptation of plants and know and apply relevant methods of plant phenotyping. Students will be able to document and evaluate the experiments carried out. They can independently work out a given topic with the aid of English technical literature and present it in an understandable way.

Forms of teaching
Lecture, practical course, seminar

Content
Lecture:
(1) Origin of the phenotype: Genotype phenotype
(2) Genetic and environmental adaptation: ecotypes; mutants; "green re-evolution"; environmental adaptation; stress adaptation
(3) Morphological and physiological adaptation: structure function; pattern formation; adaptation of resource use and distribution
(4) Physiological adaptation: drought stress; heat stress
(5) Light adaptation: sun and shadow leaves; "Shade Avoidance Syndromes"; pho-receptors; adaptation to temporally dynamic and spatially heterogeneous lighting conditions

Practical course:
(1) Morphological analyses: shoot architecture; leaf morphology
(2) Analysis of leaf growth: determination of growth rate; fresh and dry weight
(3) Analysis of photosynthesis: chlorophyll fluorescence analysis
(4) Determination of ingredients (e.g. pigments, carbohydrates or proteins)
(5) Statistical data analysis and presentation of results

Seminar: Selected Topics on Light Adaptation (Literature Seminar); Presentation of Experimental Results (Lecture)
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** None
Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course; (2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment; (3) skill area scientific presentation (10% of grade): preparation, presentation and discussion of a subject related publication/seminar.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical course) (3) Punctual submission of scientific protocol (4) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☒ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ The module takes place at the Research Centre Jülich.

V485

V485 - Modellorganismus Drosophila

V485 - Model Organism Drosophila

Coordinator (responsible lecturer) Prof. Dr. Hermann Aberle (aberle@uni-duesseldorf.de)			**Status:** 06.07.2018
Lecturers Prof. Dr. Hermann Aberle			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Hermann Aberle (aberle@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

The students learn basic techniques and work steps in dealing with the model organism Drosophila melanogaster. They are able to plan and carry out simple experiments (e.g. analysis of mutants, overexpression of genes). The students can precisely document and evaluate the experiments.

Forms of teaching

Lecture with practical exercises in the laboratory

Content

In addition to basic facts about the development of the nervous system and other tissues during embryonic development, students receive detailed information about the methods and techniques used in the module. In the practical part the students learn how to handle Drosophila cultures as well as visible markers, typical balancer chromosomes and genetic constructs. Under guidance, they investigate the cellular adhesion protein Fasciclin-II at mRNA and protein level using immunohistochemical methods and confocal microscopy. The results obtained are processed and evaluated independently on the computer.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Preparation based on the script

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (80% of grade): written examination
(2) skill area documentation (20% of grade): written protocol

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol

Relevant for following study programs/major

Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V487	V487 - Systematik der Blütenpflanzen V487 - Systematics of flowering plants

Coordinator (responsible lecturer) Prof. Dr. Jürgen Zeier (Juergen.Zeier@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Jürgen Zeier, Dr. Ulf Schmitz			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Jürgen Zeier (Juergen.Zeier@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

The students can classify different plant species of the native vegetation into families on the basis of habitus and flower characteristics. With the help of identification books, they are able to carry out species identification. The students are familiar with the flora of typical native habitats and can distinguish structural and chemical characteristics of different taxa of the angiosperms. The students can document the experiments carried out in the form of a protocol, interpret the results and place them in an overall context. Students will be able to plan, prepare and present a presentation to a target group on a given topic of the module.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

- Criteria and Methods of Systematics (Structural and Molecular Systematics)
- Phylogenetic-systematic overview of the angiosperms
- Characteristics of selected families
- useful plants
- Phytochemical aspects and plant secondary metabolism

Practical course:

- Application of determination keys for species determination
- Botanical excursions to selected native sites, description of site characteristics and ecological adaptations
- Crop plant excursion (Botanical Garden)
- Analytical-chemical identification of selected secondary substance classes

Seminar:

Selected Original and Review Papers on the

- Systematics, ecophysiology and phytochemistry of flowering plants
- Importance of crops and crop plants as well as genetic engineering aspects

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (15% of grade): written records of plant identification;
(3) skill area scientific presentation (15% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course and field trips)
(3) Punctual submission of records of plant identification
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V488	V488 - Molekulare Evolution
	V488 - Molecular Evolution

Coordinator (responsible lecturer) Prof. Dr. Laura Rose (laura.rose@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Laura Rose (laura.rose@hhu.de), Dr. Thorsten Klösges (thorsten.kloesges@hhu.de)			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Laura Rose (laura.rose@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer-term	**Group size** 14	**Duration** 1 semester

Learning outcomes/skills
Students will be able to describe the basic concepts of molecular evolution. Students can independently evaluate large amounts of data in spreadsheet and statistical programs. Students can discuss their results using primary and secondary literature.

Forms of teaching
Lectures, discussions, practical exercises in the computer laboratory

Content
Lecture:
The basic aspects of molecular evolution are covered. This includes protein sequence evolution, nucleotide sequence evolution, molecular clock, relative rate test, neutral theory, almost neutral theory, origin and evolution of gene families, and population genetic and phylogenetic methods. Students are shown the different forms of natural selection such as directed, balanced and negative selection and are taught the most advanced methods for identifying natural selection and genome evolution. These topics will be intensified by reading primary literature and discussing it during the lecture.

Exercise:
The exercises take place in the computer lab and the students apply the methods from the lecture in practical tasks. They will learn how to use public sequence databases, such as NCBI, to find and download DNA or protein sequences. They use freely available software to create alignments of these sequences. This is used for population genetic analysis with the software DnaSP and phylogenetic analysis with the programs PAUP and Mr. Bayes. At the end of the course the students present the results of their analyses.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination; (2) skill area scientific presentation (30% of grade)
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation on the excercises (3) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☒ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V489

V489 - Einführung in die statistische Analyse mittels Computersimulationen

V489 - An Introduction to Statistical Analysis Based on Computer Simulation

Coordinator (responsible lecturer) Prof. Dr. Martin Lercher (lercher@cs.uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Dr. Pablo E. Verde, Prof. Dr. Martin Lercher			**Semester:** 5. – 6.
Contact and organization Dr. Gabriel Gelius-Dietrich (geliudie@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer-term	**Group size** 10	**Duration** 1 semester

Learning outcomes/skills

Students will be able to describe and explain Bayesian methods for real world modelling. Students can use the software R and WinBUGS to perform Bayesian modelling and analyse Bayesian models critically.

Forms of teaching

Lecture and seminaristic lessons with practical exercises

Content

- Introduction to Bayesian thinking,
- Monte Carlo simulation methods,
- Markov chains Monte Carlo methods,
- Statistical modelling.

Further information is available at the following website:

http://www.cs.hhu.de/lehrstuehle-und-arbeitsgruppen/bioinformatik/lehre-und-abschlussarbeiten/lehrveranstaltungen/einfuehrung-in-die-statistische-analyse-mittels-computersimulationen.html

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (80% of grade): oral examination about the content of the course;
(2) skill area Application of the acquired knowledge (20% of grade): solve the exercises

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge

(2) Pass written examination of skill area Application of the acquired knowledge (3) Regular and active participation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Master of Computer Science
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☒ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V490	V490 - Krankheiten des zentralen Nervensystems V490 - Diseases of the central nervous system

Coordinator (responsible lecturer) PD Dr. Carsten Berndt			**Status:** 06.07.2018
Lecturers Dr. Carsten Berndt, Dr. Tim Prozorovskiy			**Semester:** 5. – 6.
Contact and organization Dr. Carsten Berndt (carsten.berndt@med.uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 6	**Duration** 1 semester

Learning outcomes/skills

Students can

- Define various diseases of the CNS and explain their underlying molecular mechanisms, as well as represent important cellular signaling pathways in development, disease and regeneration.
- explain the underlying theory of certain biochemical, molecular biological, and cell biological methods
- carry out these methods under guidance (the low number of participants ensures practical training for each participant)
- describe and present the experiments carried out and the data obtained as posters ready for publication
- derive a suitable topic for the module, create a presentation for the target group and present and discuss it in front of a group
- to practice the use of the scientific language English in word and writing

Forms of teaching

Practical course-accompanying lecture

Practical course with independent test execution in groups of two and subsequent presentation of the results

Seminar presentation (Powerpoint presentation) of each Participants

Content

Practical course accompanying lecture:

Development of the central nervous system, structure and cell types of the central nervous system; autoimmune diseases; neurodegenerative diseases; model organisms for development and diseases of the central nervous system, regeneration; molecular bases of development, diseases and regeneration of the central nervous system (signaling pathways, cell death mechanisms)

Practical course: depending on the current research; methods: cell culture, immunohistochemistry, western blot, quantitative PCR, recombinant protein expression
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Interest in Neurobiology and Cell Biology
Examination types Learning portfolio consisting of: (1) skill area knowledge (50% of grade): written examination about the content of the lectures and the practical course (English/German); (2) skill area documentation (25% of grade): Creation of a poster based on the evaluation of the practical course trials (English); (3) skill area scientific presentation (25% of grade): Seminar presentation on a self-chosen topic matching the module (English)
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical course) (3) Presentation of a scientific poster (4) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ( ) German ( ) English (x) German and English ( ) German, English on demand
Additional information Registration for the practical course is decentralized and is handled by Dr. Carsten Berndt (carsten.berndt@med.uni-duesseldorf.de). Deadline for registration is three weeks before the 1st round of LSF registrations.

V492	V492 - Proteinfaltung und Proteinfehlfaltungskrankheiten V492 - Protein Folding and Protein Misfolding Diseases		
Coordinator (responsible lecturer) Dr. Philipp Neudecker (philipp.neudecker@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Dr. Philipp Neudecker			**Semester:** 5. – 6.
Contact and organization Dr. Philipp Neudecker (philipp.neudecker@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 6	**Duration** 1 semester

Learning outcomes/skills

Students will be able to explain the basic thermodynamic and structural concepts and models of protein folding. They have an overview of the available biophysical methods for the investigation of protein folding equilibria and the advantages and disadvantages of these methods. You can perform and evaluate a selection of these methods (especially CD and NMR spectroscopy) independently. They know about the existence and importance of cellular mechanisms of protein homeostasis. They know the relationship between misfolding and aggregation and can describe the characteristic structural principles of different classes of aggregates (oligomers, amorphous aggregates, amyloid fibrils). They have an overview of the available biophysical methods for the investigation of protein aggregation and can independently perform and evaluate a selection of these methods (in particular colorimetric assays, CD spectroscopy). They know the most important biological functions of amyloids on the one hand and amyloid diseases including infectious forms (prion diseases) on the other hand. They have an insight into the current hypotheses on toxicity and pathogenicity mechanisms of amyloids as well as into the approaches to diagnosis and therapy of amyloidoses and the associated challenges. Students will be able to document and discuss the experiments conducted. They can develop a given topic from the current English-language specialist literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

- Repetition of basic principles of protein structures and relevant physical interactions in solution, protein structure elucidation
- Thermodynamic principles of protein folding
- Convolutional kinetics, Arrhenius model, transition states, intermediates, typical time

scales, Levinthal paradox

- Experimental methods to study the kinetics, thermodynamics and structure of protein folding equilibria (CD, fluorescence, NMR spectroscopy, equilibrium/heat denaturation, stopped/quenched flow, T-/p-/E-jump, calorimetry, Φ-values)
- Theoretical methods (e.g. molecular dynamics simulations, Go model, ROSETTA, FoldIt)
- Model concepts in protein folding (random coil, framework model, hydrophobic collapse, nucleation condensation, molten globules, folding funnel, frustration, crowding)
- protein homeostasis (protein synthesis, chaperones, cellular degradation machinery)
- Relationship between protein folding, misfolding and aggregation
- Basic structural principles of protein aggregates (oligomers, amorphous aggregates, amyloid fibrils)
- Experimental methods to study protein aggregation (colorimetric assays, CD-, FT-IR-, ssNMR-spectroscopy, EM, AFM, X-ray fiber diffraction, light scattering, ultracentrifugation)
- Biological functions of amyloid fibrils (e.g. as matrix, for protein inactivation, for storage of peptide hormones in secretion vesicles)
- Important amyloidoses (Alzheimer's disease, Parkinson's disease, ALS, type II diabetes, cataract, etc.)
- Infectious amyloidosis / prion diseases
- Hypotheses on toxicity and pathogenicity mechanisms of amyloidoses
- Approaches to (early) diagnosis and therapy of amyloidosis and related challenges

Practical course:

- CD spectroscopy (secondary structure typical CD spectra; melting curve of a SH3 domain, determination of thermodynamic parameters from the melting curve, specific heat capacity of the convolution)
- NMR spectroscopy (basics; recording of one- and multidimensional NMR spectra; processing and analysis of the spectra with NMRPipe and NMRView; measurement of the H/D-amide proton exchange of a SH3 domain, determination of the protective factors, secondary structure analysis of the convolution intermediate; Recording of CPMG experiments, determination of the folding kinetics and reconstruction of the chemical shifts of the folding intermediate and the denatured state from the CPMG data, secondary structure determination from chemical shifts with RCI, outlook: TALOS+, CSROSETTA, CamShift)
- Quantification of the temporal course of fibril formation of the Aβ peptide by thioflavin T fluorescence (basics; observation of the delay phase, nucleation growth model)
- Visualization and analysis of native protein structures, folding intermediates, oligomers and fibrils with bioinformatic methods

Seminar:
Each participant gives a lecture on a current research topic in the field of protein folding and protein misfolding diseases based on the English literature.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed

Content-related: The basic principles of the structure of amino acids and protein structures as well as the concept of chemical equilibrium are assumed and only briefly repeated.

Examination types

Learning portfolio consisting of: (1) skill area knowledge (70% of grade): oral examination about the content of the lectures and the practical course; (2) skill area documentation (20% of grade): written protocol (Presentation of the basics, documentation of the essential work steps, evaluation and discussion of the experiments); (3) skill area scientific presentation (10% of grade): Seminar presentation (elaboration of the material, graphic presentation of the contents, lecture, discussion).
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical course) (3) Punctual submission of scientific protocol (4) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V493

V493 - Von der Genomsequenz zur Proteinexpression

V493 - From genome sequence to protein expression

Coordinator (responsible lecturer) Prof. Dr. Petra Bauer (petra.bauer@hhu.de)			**Status:** 01.10.2018
Lecturers Dr. Tzvetina Brumbarova, Dr. PD Rumen Ivanov			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Petra Bauer (petra.bauer@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

The students know the basic concepts, the theoretical background and procedure for the production of a recombinant plasmid based on genome sequence information and subsequent use of the plasmid for controlled protein expression in cells. At the end of the course, students will be able to develop an experimental plan. They explain the necessary intermediate steps and expected experimental intermediate results using their own flowchart. The students name control experiments that are essential for the interpretation of the results and explain whether cloning and protein expression were successful or in which intermediate steps problems occurred. They can explain the principles of the methods. The students name and explain application examples for cloning and protein expression. Students will be able to plan and practically carry out simple experiments/techniques in the laboratory, record and evaluate the experiments carried out. The students are able to work independently and properly with the basic measuring instruments and other apparatus and instruments from the laboratory. The students create a target group-oriented presentation in the form of a lecture. The students recognize the milestones of the practical work (essential intermediate results and final results) and present them clearly in suitable illustrations.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

Genome sequence, genome databases, model systems, cloning strategies and procedures, plasmids and properties, DNA analysis (PCR, restriction enzymes, sequencing), ligation, transformation, E. coli strains and properties, selection, stable and transient protein expression, protein extraction, concentration determination, protein gel electrophoresis, protein detection, fusion proteins, application examples of cloning and protein expression by publication, planning of experiments, flow diagrams, data analysis, presentation of results...

Practical course:
In silico sequence analysis, cloning of DNA fragments into a protein expression vector (PCR, restriction, ligation, transformation E. coli, selection, plasmid DNA purification, sequencing, protein expression (e.g. in E. coli), protein extraction, protein concentration determination, SDS-PAGE, western blot, coumassie staining.

Seminar:
Students give presentations on the experimental procedure and its results.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (60% of grade): oral examination about the learning outcomes, contents of the lecture and the practical course;
(2) skill area documentation (20% of grade): written protocol;
(3) skill area scientific presentation (20% of grade): presentation.

Requirements for the award of credit points for this course
(1) Pass oral examination of skill area knowledge
(2) Regular and active participation
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation on experimental approaches and results from the module, which meets the requirements for scientific documentation and presentation.

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V496	V496 - Quantitative Genetik der Pflanzen V496 - Plant Quantitative Genetics		
Coordinator (responsible lecturer) Prof. Dr. Maria von Korff Schmising (korff@mpipz.mpg.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Maria von Korff Schmising and staff members			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Maria von Korff Schmising (korff@mpipz.mpg.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 8	**Duration** 1 semester

Learning outcomes/skills

Students will be able to describe and explain basic concepts and methods of quantitative plant genetics as well as apply the acquired methodological knowledge in practice. Students can precisely document and evaluate the experiments carried out. They can independently work out a given topic with the aid of English language specialist literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

(1) Introduction to the basics of population genetics and quantitative genetics: genetic variance, population structure, selection, mutation, genetic drift, Hardy vineyard equilibrium, phenotypic variance.
(2) Introduction to plant genomics: molecular markers, genetic map generation, sequencing methods, next-generation sequencing, genome assembly
(3) Introduction to the mapping of quantitative properties: QTL (quantitative trait locus) analysis, association mapping, phenotyping, QTL accounting procedures, molecular isolation of QTL.
(4) Application of quantitative genetics in plant breeding: breeding methods, marker-assisted selection, genomic selection.

Practical course:

(1) sequencing of candidate genes in various barley lines, sequence analysis, analysis of genetic diversity
(2) Design of molecular markers for genotyping, creation of a genetic map in a segregating barley population
(3) Phenotyping of developmental characteristics of the barley population in different environments (control and stress conditions), determination of genetic and environmental

variance.
(4) Performing a QTL analysis using genetic markers, determining QTL effects in different environments.

Seminar:
Selected original and review papers on quantitative genetics and genomics in crop plants.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (10% of grade): preparation and presentation of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
The module takes place at the Max Planck Institute for Plant Breeding Research in Cologne. A shuttle bus is available for the transport from Cologne main station to MPIPZ.

V497

V497 - Einführung in die Biostatistik mit R

V497 - Introduction in Biostatistics using R

Coordinator (responsible lecturer) Prof. Dr. Andreas Weber (andreas.weber@hhu.de)			**Status:** 01.10.2018
Lecturers Dr. Veiko Krauß			**Semester:** 5. – 6.
Contact and organization Dr. Veiko Krauß (veiko.krauss@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

The students can safely use the programming environment R to restructure and visualize biological data collections. You can use R for descriptive and concluding statistical investigations, always taking into account the possibilities and limitations of the methods used.

Forms of teaching

Lecture and independent practical exercises on the computer

Content

Lecture:

R Programming Environment, Data Restructuring, Loops, Scripts, Basics of Statistics, Role of Forms in Graphics, Hypothesis Testing, ANOVA, Correlation, regression

Exercises:

The exercises serve to convey the basic operating principles of R including installation, data entry and transformation, creation of loops and scripts, the graphical representation of data, the correct application of statistical tests as well as the implementation of various other methods such as correlation, regression and and ANOVA. The theoretical basics are imparted promptly in the exercises. For Exercises are used to create biology-typical data sets.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed

Content-related: None

Examination types

Learning portfolio consisting of:

(1) skill area knowledge (60% of grade): written examination about the content of the lectures and the practical course;

(2) skill area documentation (40% of grade): Exercises of programming in R (tasks during the course);

Requirements for the award of credit points for this course

(1) Pass written examination of skill area knowledge

(2) Regular and active participation (exercises)

(3) Documentation of the exercises
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ Place and time will be announced in the LSF. Lecture scripts and exercises will be made available via the Ilias portal. Literature: Field A, Miles J, Field Z (2012) Discovering Statistics Using R. SAGE Los Angeles etc. ISBN: 978-1-4462-0045-2.

V501

V501 - Biophysik der Zelle

V501 - Physical Biology of the Cell

Coordinator (responsible lecturer) Prof. Dr. Matias Zurbriggen (Matias.Zurbriggen@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Matias Zurbriggen, Prof. Dr. Alexander Büll (Alexander.Buell@uni-duesseldorf.de)			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Matias Zurbriggen, Prof. Dr. Alexander Büll (Alexander.Buell@uni-duesseldorf.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer- and every winter-term	**Group size** 15	**Duration** 1 semester

Learning outcomes/skills

Students can describe and explain basic biophysical processes in the field of cell and molecular biology. They have a quantitative understanding of fundamental biological processes. They are able to operate the types of measuring instruments used in this module safely and evaluate their output independently. They are able to properly document and interpret the results of their experiments and to present them orally and in writing.

Forms of teaching

Lecture, literature seminar, exercises, practical course with protocol

Content

Lecture:

Provides the mathematical and physical basics of cell and molecular biology, focusing on fundamental physical concepts that are essential for a quantitative understanding of biological processes. The students are also familiarized with modern methods of Synthetic Biology, which allow a quantitative description of cellular processes. Students will learn that the application of less basic physical models enables a quantitative understanding of biological processes as different as cell division or protein aggregation in neurodegenerative diseases (Alzheimer, Parkinson).

Exercises:
Will deepen the quantitative part of the course and develop an understanding of the importance of mathematical models in cell and molecular biology. The exercises will be discussed with the students.

Practical course:
In the practical part of the biophysics course, quantitative approaches to biological problems are practiced using simple model systems (enzyme kinetics, cell growth). Furthermore, quantitative genetically coded biosensors for plant hormones are used for the determination of hormone levels in cells with highest sensitivity and specificity. Students are instructed to complete their project with a protocol including detailed data analysis.
Literature seminar of the students on classical and current original papers on the topics of the lecture and the practical course.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Physics and biophysics contents of the 1st and 3rd semester respectively

Examination types
Learning portfolio consisting of:

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation
(3) Punctual submission of scientific protocol

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
-

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☒ English
☐ German and English
☐ German, English on demand

Additional information
The module is assigned centrally. The textbook "Physical Biology of the Cell" (2nd edition) by Phillips / Kondev / Therio / Garciat will be used.

V504	V504 - Big Data Biologie V504 - Big Data Biology		
Coordinator (responsible lecturer) Jun.-Prof. Dr. Ing. Ilka Maria Axmann (Ilka.Axmann@hhu.de)			**Status:** 01.10.2018
Lecturers Jun.-Prof. Dr. Ing. Ilka Maria Axmann, Jun. Prof. Dr. Mathias Beller, M.Sc. Nicolas Schmelling			**Semester:** 5. – 6.
Contact and organization M.Sc. Nicolas Schmelling (Nicolas.Schmelling@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 10	**Duration** 1 semester

Learning outcomes/skills

The students have the basics of the programming language Python. With the help of the programming language Python they are able to analyze data sets reproducibly, to evaluate the results statistically and to interpret the data afterwards. You will learn to evaluate and analyze data and to graphically present the most important findings in a form that is ready for publication.

Forms of teaching

Lecture and independent practical exercises on the computer

Content

Lecture:

The lecture deals with the basics of data intensive biology. Students will be introduced to the basic principles of high-throughput technologies (DNA sequencing, microarray, mass spectrometry, flow cytometry, expression and growth monitoring). In addition, the central concepts of descriptive and inductive statistics as well as data visualization are taught.

Exercise:

Basic elements of the programming language Python (Variables, String, Numbers, Lists, Dictionaries, Functions) and advanced modules (Numpy, Pandas, Scipy, Scikit Learn, Matplotlib, Seaborn) are taught. Furthermore, the theoretical basics of data analysis through

data visualization and statistics with the help of applications are deepened in the exercise.
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** None
Examination types Learning portfolio consisting of: (1) skill area knowledge (50% of grade): written examination about the content of the lectures; (2) skill area Application of the acquired knowledge (35% of grade): Exercises, handing in exercise solutions.; (3) skill area scientific presentation (15% of grade): presentation
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (50%) (2) Pass written examination of skill area Application of the acquired knowledge (3) Regular and active participation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ Place and time will be announced in the LSF. Lecture scripts and exercises will be made available via the Ilias portal.

V506	V506 - Symbiose und die Evolution eukaryotischer Kompartimente V506 - Symbiosis and the evolution of eukaryotic compartments		
Coordinator (responsible lecturer) PD. Dr. Sven Gould (gould@hhu.de)			**Status:** 01.10.2018
Lecturers PD. Dr. Sven Gould			**Semester:** 5. – 6.
Contact and organization PD. Dr. Sven Gould (gould@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer- and every winter-term	**Group size** 18	**Duration** 1 semester

Learning outcomes/skills

Upon completion of the module, students will have mastered the basics of combining work in the (wet) laboratory with work on the computer. They will be able to analyse an environmental sample in terms of its biodiversity, both microscopically and using molecular experiments. They will also be able to isolate DNA from environmental samples, sequence it and analyse it phylogenetically. Students will also be able to use basic methods of cell disruption, centrifugation and sample preparation for protein isolation. Students can isolate proteins and analyze them by various methods, including SDS-PAGE and quantitative multiplex western blots. They can document their results scientifically, interpret them critically and partly compare them with existing literature.

Forms of teaching

Lecture with practical exercises in the laboratory

Content

Basics of eukaryotic evolution and eukaryotic micro- and cell biology.

Transition from symbiosis to endosymbiosis and parasitism.

From proteobacterium to mitochondria and from cyanobacterium to land plant plastids.

Environmental Sample Processing for 18S PCRs & Sequencing

Simple phylogenetic analyses: Alignments and phylogenetic trees

Basics of cell subfractionation (plastid isolation) and protein analysis (SDS-PAGE, quantitative multiplex western blots, protein turnovers, etc...) of the resulting fractions.

Further information is available at the following internet address:

www.molevol.hhu.de/unsere-lehre/

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (50% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (50% of grade): written protocol (written evaluation and discussion of scientific results)

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course, lectures and seminar)
(3) Punctual submission of scientific protocol

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
-

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
Attendance at the preliminary meeting is compulsory.

V507	V507 - Glykobiologie V507 - Glycobiology		
Coordinator (responsible lecturer) Prof. Dr. Markus Pauly (m.pauly@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Markus Pauly			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Markus Pauly (m.pauly@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer- and every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

The students will learn basic concepts on the structure and function of various carbohydrates found in bacteria, fungi, plants, and animals. The knowledge will then be applied to experimentally analyze carbohydrates in detail. Students will be able to document and analzye their experiments. In addition, they will be able to present a current glycobiology topic from primary literature in front of the group.

Forms of teaching

Lecture, practical course, presentation

Content

Lecture:

(1) Initially, the lectures will focus on the structural diversity of carbohydrates, which is necessary to understand their various biological roles.
(2) Then, a section will focus on the analytical methods that have been developed to analyze carbohydrate structures in detail (some of these methods will also be performed in the practical part of this module, see below).
(3) The majority of the lectures will discuss the functions of carbohydrates and glycoconjugates present in bacteria, fungi, plants, and animals including humans.

practical course:

(1) Calculation and preparation of buffers and stock solutions

(2) Separation of carbohydrates via size-exclusion chromatography and analysis of the data.
(3) Monosaccharide-composition analysis via derivatisation and analysis by GC-MS and HPLC
(4) Determination of the glycosidic linkage of a carbohydrate sample by derivatization and analysis by GC-MS and analysis of the data
(5) Enzymatic digest of a carbohydrate sample and analysis of the products via MALDI-TOF MS and gel-electrophoresis.

Presentation:
Selected primary scientific articles including review articles on the function of carbohydrates. Students should be able to prepare a presentation and present it in front of the group.

Eligibility
Formal: All modules of the undergraduate-level courses (1. – 4. Sem.) need to be completed
Content-related: English language skills to understand/ read English lectures and literature

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (60% of grade): written examination (1h) about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;
(3) skill area scientific presentation (20% of grade): preparation, presentation and discussion of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Regular attendance (lectures, practical course and seminar).
(2) Pass written examination of skill area knowledge
(3) On schedule/ punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☒ English
☐ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V508	V508 - Bioakustik V508 - Bioacoustics		
Coordinator (responsible lecturer) Prof. Dr. Christine R. Rose (rose@uni-duesseldorf.de)			**Status:** 06.07.2018
Lecturers Dr. K. Kafitz			**Semester:** 5. – 6.
Contact and organization Dr. K. Kafitz (Kafitz@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** Not applicable winter-term 2019/20	**Group size** 27	**Duration** 1 semester

Learning outcomes/skills

Students are able to describe, explain and compare the basic concepts and mechanisms of the functioning of the human acoustic and visual system at the cellular and organ level. They can transfer these concepts to other sensory systems and evaluate them with regard to common principles and significant differences.
Under supervision, students can carry out basic experiments on the performance and physiology of the acoustic system, document them precisely and evaluate, assess and adequately describe the results obtained and present them orally. Students are able to work independently and appropriately with the basic measuring devices and other apparatus or instruments of sensory physiology. Students are able to adequately evaluate and interpret the experimental data and to present them coherently in written and spoken form. The students are able to plan and create a presentation on a given topic of the module, which is suitable for the target group and to present it to a group.

Forms of teaching

Lecture, exercise and practical course

Content

Lecture:
Cross-species presentation of the construction of the ear, its organ function, and the cellular mechanisms of stimulus uptake. Connections of the ear with the central nervous system, and central nervous representation of acoustic stimuli. Performance of the acoustic system.

Psychophysical basics and pathophysiology of the auditory system.

Practical course:
Acoustic system: Hearing threshold curve, pathophysiology of hearing, impedance matching, airborne and bone sound, directional hearing, vocalization and phonation, sound pattern analysis, vocalization pause analysis, speech analysis of letters and simple sentence structures, consensual performance related to hearing.

Exercise:
Theoretical development and presentation of hearing models.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic knowledge of neurophysiology from module Bio220 is required.

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area Design of experiments, conduct and documentation (15 % of grade): oral presentation and discussion
(3) skill area scientific presentation (15% of grade): Short presentation.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course, lectures and Exercises)
(3) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry, Bachelor Physics

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☒ German
☐ English
☐ German and English
☐ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V509

V509 - Grundlagen der Populations- und quantitativen Genetik

V509 - Principles of population and quantitative genetics

Coordinator (responsible lecturer) Prof. Dr. Benjamin Stich (benjamin.stich@hhu.de)			**Status:** 01.10.2018
Lecturers Dr. Delphine Van Inghelandt; Prof. Dr. Benjamin Stich			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Benjamin Stich (benjamin.stich@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 30	**Duration** 1 semester

Learning outcomes/skills

Students can describe and explain basic concepts and methods of population and quantitative genetics and apply theory to solve model calculations. They can independently work on a given topic with the help of English-language specialist literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

Basics of population genetics: Hardy vineyard equilibrium, inbreeding, foreign breeding, factors of population dynamics

Fundamentals of quantitative genetics: The quantitative-genetic model, effect of genotype and environment on phenotype, components of genotypic variation, similarity between relatives

Exercises:

The theoretical basics are taught in the lecture before the exercises. In the exercises the contents are deepened by solving example calculations.

Seminar:

Literature seminar of the students about classical and current original works with thematic reference to the topics of the lecture and the exercises.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Interest in dealing with numbers and formulas

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures

and the exercises; (2) skill area Application of the acquired knowledge (10% of grade): Solving the model calculations; (3) skill area scientific presentation (20% of grade): preparation, presentation and discussion of a subject related publication/seminar.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (lectures and exercises) (3) Giving a scientific presentation in English
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ Place and time are announced in the LSF.

V510

V510 - Theorie Biologischer Netzwerke

V510 - Theory of Biological Networks

Coordinator (responsible lecturer) Prof. Dr. Oliver Ebenhöh (oliver.ebenhoeh@hhu.de)			**Status:** 01.10.2018
Lecturers Prof. Dr. Oliver Ebenhöh			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Oliver Ebenhöh (oliver.ebenhoeh@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

The students are able to characterize and describe different types of biological networks. The students are capable of applying basic techniques to analyze the structure of such networks and interpreting the results in a biological context. They can perform network analyses and solve simple problems independently and are able to relate results from different types of analyses. The students learn to work independently on a given topic, read and understand literature, and present their results in a comprehensible presentation.

Forms of teaching

Lectures and hands-on tutorials, presentations of exercises.

Content

Lecture:

Structural analysis of metabolic networks:

- Metabolic control theory
- Null space analysis, e.g. reaction correlation coefficients
- Network expansion
- Elementary flux modes and Flux Balance Analysis

Signal transduction networks:

- Transmission efficiency, time and signal amplification
- Structural properties and stability

General analysis methods:

- Graph-based methods, e.g. connectivity
- Hierarchical structures, cluster
- Network motifs

Practical course:

The theoretical foundations will be taught in the lectures before the practical courses. During

the practical courses the contents will be complemented by hands-on computer work. The exercises serve in particular to familiarize the students with the programming language Python. During the practical courses, simple algorithms will be implemented and applied to analyze biological networks. Classical works in theoretical biology will be reproduced and investigated in detail.
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Basic mathematical knowledge, basic experience in any programming language is helpful.
Examination types Learning portfolio consisting of: (1) skill area knowledge (60% of grade): Written exam (or oral in case of less than 8 participants) on the content of the lectures and practical courses; (2) Presentation of exercises or seminar talk (40% of grade).
Requirements for the award of credit points for this course (1) Regular and active participation in lectures and practical courses (2) On-time submission of homework exercises, which must at least fulfill minimal standards (3) Passing the final examination
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula -
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V511

V511 - Python Programmierung für Naturwissenschaftler/innen

V511 - Python programming for scientists

Coordinator (responsible lecturer) Prof. Dr. Benjamin Stich (benjamin.stich@hhu.de)			**Status:** 01.10.2018
Lecturers Dr. David Ries, Prof. Dr. Benjamin Stich			**Semester:** 5. – 6.
Contact and organization Dr. David Ries (riesd@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Frequency** every summer-term	**Group size** 10	**Duration** 1 semester

Learning outcomes/skills

Students have basic programming skills in the programming language Python. Data sets of biological high-throughput methods can be read in, processed and analysed. The students are able to visualize the results of data analysis with suitable presentation methods. They can independently identify the requirements of an analysis pipeline and implement them in a team. Furthermore, by discussing the tasks and planning the solution together, the ability to independently analyse problems and implement programming solutions is strengthened.

Forms of teaching

Lecture, Exercises

Content

Lecture:

The theoretical as well as practical basics of programming paradigms are presented in the lecture.

Programming: data types, data flow, I/O, parsing of text files, sorting, function definitions, visualization with matplotlib, "regular expressions

Applications in the biological context: processing qPCR data, parsing RNA-Seq data, processing GenBank data, basic plotting of diagrams, bar charts, chromosome plotting, heatmaps, dendrograms, distance matrices, Euclidean distance, clustering, independent programming

Exercises:

In the exercises, the programming paradigms are consolidated and deepened through practical programming tasks. The students work on a programming project in small groups.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed

Content-related: Basic skills in handling a computer. Interest in programming. Interest in solving intellectually challenging problems.

Examination types

Learning portfolio consisting of: (1) skill area knowledge (60% of grade): written examination about the content of the lectures and the exercises; (2) skill area Application of acquired knowledge (40% of grade): Implementation of the minimum programming requirements and at least two optional modules of the programming project
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Pass written examination of skill area Application of acquired knowledge (3) Regular and active participation (lectures and exercises)
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☐ German and English ☒ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/ Place and time will be announced in the LSF.

V512

V512 - Versuchsanlage und -auswertung mit R

Experimental design and analysis using R

Coordinator (responsible lecturer) Prof. Dr. Benjamin Stich (benjamin.stich@hhu.de)			**Status:** 27.03.2019
Lecturers Dr. Delphine Van Inghelandt, Prof. Dr. Benjamin Stich			**Semester:** 5. – 6.
Contact and organization Dr. Delphine Van Inghelandt (inghelan@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 30	**Duration** 1 semester

Learning outcomes/skills

The significance of experimental investigations depends decisively on the choice of suitable test facilities and the corresponding evaluation. This module is offered to prepare for the execution and subsequent statistical evaluation of experimental BSc and MSc theses. After successful completion of the module, the participants can plan their own surveys and experiments according to statistical aspects. The participants can characterize different statistical methods with respect to the underlying assumptions, select the methods suitable for their own data and questions and implement them in the software R. They can independently work out a given topic with the help of English language technical literature and present it in an understandable way.

Forms of teaching

Lecture, Exercises, seminar

Content

Lecture:

Data types, descriptive statistics, t-test, two-step sampling, two-factorial analysis of variance, linear regression, nonlinear regression, multiple regression, polynomial regression, data transformations, principles of experimental design, important experimental facilities (block plant, Latin square, incomplete blocks, slit line, strip line), longitudinal data, test series, mixed models, Best Linear Unbiased Estimation (BLUE), Best Linear Unbiased Prediction (BLUP), methods for variance component calculation. Contingency tables, introduction to some multivariate methods (principal component analysis, factor analysis, cluster analysis, discriminant analysis).

Exercises:

The theoretical basics are taught in the lecture before the exercises. In the exercises the contents are deepened by analysing example data sets mainly from plant sciences with the software R.

Seminar:
Literature seminar of the students about classical and current original papers with thematic reference to the topics of the lecture and the exercises.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic knowledge of the R software is beneficial. Interest in dealing with numbers and formulas

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (50% of grade): written examination about the content of the lectures;
(2) skill area Application of acquired knowledge (30% of grade): Solving programming tasks;
(3) skill area scientific presentation (20% of grade): preparation and presentation of a subject related publication/seminar.

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Pass written examination of skill area Application of acquired knowledge
(3) Regular and active participation (lectures and exercises)
(4) Giving a scientific presentation in English

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/
Place and time will be announced in the LSF.

V515

V515 - Strategien zur Entwicklung von Stresstoleranz in Nutzpflanzen

V515 - How to engineer stress tolerant crops

Coordinator (responsible lecturer) Prof. Dr. Wolf B. Frommer (frommer@hhu.de)			**Status:** 01.10.2018
Lecturers Dr. Thomas Hartwig, Dr. Thomas Kleist, Dr. Joon Seob Eom, Prof. Dr. Wolf B. Frommer			**Semester:** 5. – 6.
Contact and organization Dr. Thomas Hartwig (thartwig@mpipz.mpg.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

- Conceptual and practical understanding of drought stress and gene regulation
- Practical experience measuring drought phenotypes of differently adapted maize lines
- Practical experience in molecular cloning, *in vitro* protein expression and quantitative PCR
- Conceptual and practical understanding of genetic diversity and its potential to identify targets for genome editing

Forms of teaching

Lecture, practical course, presentation

Content

Lectures:

- Challenges for sufficient water supply in the world
- Principles and physiological processes of drought stress
- Transcriptional gene regulation: promotors, enhancers, transcription factors, differential expression
- Gene regulation under drought stress
- Genetic and epi-genetic variation: alleles, SNPs, INDELs, open chromatin, methylation
- Quantitative genetics to discover biological function: QTLs, GWAS, allele-specific binding/expression
- Strategies for genome editing: TALEN, CRISPR/Cas

Praktikum:

- Quantification of drought stress in diverse maize ecotypes
- Quantitative methods to determine gene regulation under drought stress
- Molecular cloning and DNA sequencing
- *In vitro* protein expression

- *In vitro* protein-DNA binding / DNA affinity purification

Seminar:
Students will give short presentation on current papers in the fields of drought stress, natural variation or genome editing

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
- 50% Written exam (end of course)
- 30% Oral presentation (middle of course)
- 20% Protocol of practical course (end of course)

Requirements for the award of credit points for this course
- Completion of written exam
- Regular and active participation in the practical course
- Completion of short talk
- Completion of a scientifically acceptable research protocol

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemie

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
The module will be held at the Max Planck Institute in cologne. A bus for the transfer from HHU will be provided. Registration via LSF https://lsf.uni-duesseldorf.de/

V516	V516 - Entwicklungsbiologische Grundlage der Tumorentstehung am Beispiel der Darmstammzelle
	V516 - Developmental basis of tumor formation from intestinal stem cells

Coordinator (responsible lecturer) Prof. Dr. Thomas Klein (Thomas.Klein@uni-duesseldorf.de)			**Status:** 11.02.2019
Lecturers Dr. Tobias Reiff (reifft@hhu.de)			**Semester:** 5. – 6.
Contact and organization Dr. Tobias Reiff (reifft@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills
The students are able to describe and explain basic mechanisms of stem cell-based intestinal homeostasis and tumorigenesis in Drosophila melanogaster. In the practical part, selected genetic and histochemical experiments are performed and microscopically analysed.

Forms of teaching
Lecture, practical course with independent experiment execution, preparation of a protocol of the experiments on tumor development carried out during the practical course.
Seminar, independent elaboration and presentation of further basics from English literature based on the lecture.

Content
The module investigates basic principles of tumorigenesis using intestinal stem cells in Drosophila melanogaster as an example. The students learn about genetic and histochemical analysis techniques. This includes the preparation of preparations, antibody staining, western blot, gene expression fluorescence sensors and genetic manipulation of expression levels. Representation and evaluation are carried out using modern fluorescence microscopy and electronic image analysis software.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area Application of acquired knowledge (20% of grade): evaluation of the protocol;

(3) skill area scientific presentation (10% of grade): Evaluation of the seminar presentation.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (3) The experiments carried out must be presented completely and correctly in the protocol (competence area 'application of acquired knowledge')
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☐ German ☐ English ☒ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V517

V517 - Ökologische Entwicklungsbiologie

V517 - Ecological Developmental Biology

Coordinator (responsible lecturer) Prof. Dr. Sebastian Fraune (fraune@hhu.de)			**Status:** 25.05.2019
Lecturers Prof. Dr. Sebastian Fraune, Dr. Jan Taubenheim			**Semester:** 5. – 6.
Contact and organization Prof. Dr. Sebastian Fraune (fraune@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

- The students know the basic concepts of the ecological developmental biology of animals and can apply them to concrete objects
- The students carry out the process of scientific work in groups on the basis of their own research projects.
- They can scientifically plan, carry out and evaluate biological questions with minimal instruction.
- The exact planning and execution of relevant procedures during experimentation supports the time management and organisational skills of the students.
- In the context of a collegial reflection of the results in the group, the students can strengthen their willingness to cooperate, expand their solution strategies and consolidate their ability to work in a team.
- They can use their own results for the professional documentation and presentation of their findings.

Forms of teaching

Lecture, practical course, seminar

Content

Lecture:

The lecture deals with the questions: How does the environment influence the development of organisms and the expression of phenotypes? How do these interactions influence diseases and the evolution of organisms? To answer these questions, we do not consider animals as independent systems, but as a network of interactions. "It seems that nothing exists except as part of a network of interactions (Scott F. Gilbert)". We look at the developing organisms in their biotic and abiotic environment, focusing on symbiosis, epigenetics and developmental plasticity. We will discuss how new insights in developmental ecology have changed the understanding of genetics, evolution, cancer research.

Seminar:

One scientific presentation per student on the experiment performed.

practical course:
The focus of this course is on practical laboratory work. In common understanding with the students, research projects within ecological developmental biology will be identified on the model organism Hydra, which will be worked on in small groups. The students independently go through the process of scientific work under the principle of minimal assistance, from the identification of a research question to the generation of hypotheses to the planning of the necessary experiments. The implementation, documentation and evaluation of the results are also carried out. Subsequently, the collegial and critical reflection of the results and the work in the groups with each other forms a valuable basis for scientific experimentation and allows the students to experience collegial cooperation as a prerequisite for successful scientific work.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (30% of grade): written protocol with results and discussion;

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (Preliminary meeting, practical course, lectures and seminar)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International, Bachelor Natural Sciences

Compatibility with other curricula
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Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☐ German and English
☒ German, English on demand

Additional information
Registration via LSF https://lsf.uni-duesseldorf.de/

V518	V518 - Elektrische Signale im Nervensystem V518 - Electrical signals in the nervous system

Coordinator (responsible lecturer) Prof. Dr. Christine Rose (Rose@uni-duesseldorf.de)			**Status:** 01.10.2018
Lecturers Ziemens, Langer, Rose			**Semester:** 5. – 6.
Contact and organization Daniel Ziemens (Daniel.Ziemens@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every summer-term	**Group size** 12	**Duration** 1 semester

Learning outcomes/skills

Students will be able to present the basic concepts for the description of electrical phenomena in excitable cells and to theoretically and experimentally understand the quantitative relationships between the various relevant parameters. They can adequately represent important methods for the investigation of physiological processes in neurons and glial cells and apply them in a practical case. Students are able to adequately evaluate and interpret experimental data and to present them coherently in written and spoken form. Students are able to plan, create and present a presentation on a given topic of neurophysiology to a target group.

Forms of teaching

Lecture and practical course with accompanying exercises

Content

Lecture:

Membrane transport: ion channels, ion pumps and transporters, thermodynamics of membrane transport, driving forces and equilibrium position, current-voltage diagrams, equivalent circuit diagrams, dose-response curves, Hill coefficient, receptor blockade/pharmacology, allosteric/competitive inhibition.
Experimental techniques: single electrodes, voltage clamp, patch clamp, ion sensitive microelectrodes, indicator dyes.
Synaptic transmission: chemical and electrical synapses, neurotransmitters and neurotransmitter-receptors, regulated exocytosis and SNARE proteins, synaptic short-term and long-term plasticity, Hebbian rule, LTP and LTD, learning and memory.
Functions of glial cells: K+ homeostasis, neurotransmitter uptake, energy metabolism.

Practical course:

Experimental investigation of simple electrical circuits to clarify neurophysiologically relevant parameters, Kirchhoff rules, capacitor recharging, low pass/high pass, Hodgkin-Huxley model;

derivation of membrane potential in identified neurons in the leech's central nervous system, influence of extracellular K+ concentration and neurotransmitters on membrane potential, application of the Gold-man-Hodgkin-Katz equation *Exercise:* Calculation tasks for ion movements, electromotive force, adjustment of the membrane potential, equilibrium position for secondary active transport systems, dose-response curves, Hill coefficient
Eligibility **Formal:** All modules of basic studies (1. – 4. Sem.) need to be completed **Content-related:** Basic knowledge of neurophysiology from module Bio220 is required.
Examination types Learning portfolio consisting of: (1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course; (2) skill area Design, conduct and documentation of experiments (15 % of grade): oral presentation and discussion; (3) skill area scientific presentation (15% of grade): short preparation.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular and active participation (practical course, lectures and exercises) (3) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry, Bachelor of Computer Science, Bachelor of Mathematics, Studium Universale
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ☒ German ☐ English ☐ German and English ☐ German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V519	V519 - Intrazelluläre Signaltransduktion von Arabidopsis V519 - Intracellular signal-transduction in Arabidopsis

Coordinator (responsible lecturer) Prof. Dr. Rüdiger Simon (Ruediger.Simon@hhu.de)			**Status:** 03.09.2019
Lecturers Prof. Dr. Rüdiger Simon, Dr. Maike Breiden			**Semester:** 5. – 6.
Contact and organization Dr. Maike Breiden (m.breiden@hhu.de)			**Mode:** optional compulsory module
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Frequency** every winter-term	**Group size** 12	**Duration** 1 semester

Learning outcomes/skills

The students can explain the basic signal transduction cascades of plant and animal cells. The students will also learn the background of different techniques used to investigate signal transduction cascades. Due to the contents of the lecture, the students are able to explain these techniques and apply them in practical training. The students are able to document, evaluate and assess the experiments performed in the practical course. They are able to independently work out a given topic with the help of English language technical literature and present it in an understandable way.

Forms of teaching

Lecture, practical course, preparation and presentation of a related topic, group work with discussion, preparation of protocols

Content

Lecture:

In this lecture signal transduction cascades are presented using plant and animal cells as examples. The students learn how extracellular signals (e.g. hormones) are perceived and processed by cells. There will be lectures on receptors, their ligands and the subsequent characteristic signal transduction cascades (e.g. G-protein coupled receptors and G-proteins, phosphorylation by kinases). Furthermore, the mechanisms by which the cells communicate with each other (e.g. reactive oxygen species) are discussed.

practical course:

In the practical course students will use biochemical and microscopic methods to trace signal transduction processes in living cells. For this purpose, different biochemical and microscopic techniques are used. In the course, Arabidopsi plants will be exposed to different phytohormones in sterile cultures in order to specifically modify the development of meristems. A changed gene expression is detected by reporter gene systems. With the help

of live cell experiments, the rapid reactions of cells to external stimuli (e.g. phytohormones) can be investigated by means of fluorescent indicators (sensors). The students learn to evaluate their experiments with the help of freely available analysis software. Confocal laser microscopy is also used in collaboration with the Center for Advanced Imaging (CAi). This high-resolution microscopy technique can be used to investigate the localization of receptors and various proteins involved in signal transduction cascades. Interactions between proteins are studied in vivo by FRET-APB.

Seminar:
Selected original papers on signal transduction in plants.

Eligibility
Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: Basic knowledge of molecular biology is required.

Examination types
Learning portfolio consisting of:
(1) skill area knowledge (80% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion;

Requirements for the award of credit points for this course
(1) Pass written examination of skill area knowledge
(2) Regular and active participation (practical course and lectures)
(3) Punctual submission of scientific protocol
(4) Giving a scientific presentation in English

Relevant for following study programs/major
Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International

Compatibility with other curricula
Bachelor Biochemistry

Significance of the mark for the overall grade
The mark given will contribute to the final grade in proper relation to its credits.
9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)

Course language
☐ German
☐ English
☒ German and English
☐ German, English on demand

Additional information
The module is assigned centrally

V529

Molekularbiologische Methoden: Protein-Protein-Interaktionen

V529 - Methods in Molecular Biology: Protein-protein interactions

Coordinator (responsible lecturer) Jun.-Prof. Dr. Wolfgang Hoyer (wolfgang.hoyer@hhu.de)			**Status:** 01.10.2018
Lecturers Jun.-Prof. Dr. Wolfgang Hoyer			**Semester:** 5. – 6.
Contact and organization Jun.-Prof. Dr. Wolfgang Hoyer (wolfgang.hoyer@hhu.de)			**Mode:** optional compulsory course
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 1 SWS Seminars: 1 SWS	**Module window** Summer term, window 5	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

Students are able to explain and apply basic techniques to generate recombinant plasmids and to exploit them for protein expression. They know concepts of protein purification using different chromatographic methods. They know, and can apply, biochemical and biophysical methods for characterization of proteins and their interactions. Students can handle basic laboratory instruments independently and appropriately. They document their results in a protocol and interpret them in relation to the scientific literature. They are able to prepare a talk based on scientific literature, and can present it in a way that is targeted to their audience.

Forms of teaching

Practical course, Lecture, Seminar

Content

General techniques from Molecular Biology and Biochemistry, covering the path from gene to protein function. Students independently perform lab methods like cloning, PCR, protein expression, protein purification, chromatography, biomolecular interaction analysis (biolayer interferometry, microfluidic diffusional sizing), atomic force microscopy, fluorescence spectroscopy.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed
Content-related: None

Examination types

Learning portfolio consisting of:
(1) skill area knowledge (70% of grade): written examination about the content of the lectures and the practical course;
(2) skill area documentation (20% of grade): written protocol with results and discussion that would allow a reproduction of the experiment;

(3) skill area scientific presentation (10% of grade): preparation, presentation and discussion of a subject related publication/seminar.
Requirements for the award of credit points for this course (1) Pass written examination of skill area knowledge (2) Regular attendance (lectures, practical course and seminar) (3) Punctual submission of scientific protocol (4) Giving a scientific presentation
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula Bachelor Biochemistry?
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ( ) German ( ) English (x) German and English ( ) German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/

V531

V531 – Introduction to modeling in biology

Introduction to modeling in biology

Coordinator (responsible lecturer) Prof. Dr. Oliver Ebenhöh			**Status:** 01.10.2022
Lecturers Dr. St. Elmo Wilken			**Semester:** 5. – 6.
Contact and organization Dr. St. Elmo Wilken (wilkenst@hhu.de)			**Mode:** optional compulsory course
Workload 270 h	**Credit points** 9 CP	**Contact time** 120 h	**Self-study** 150 h
Course components Practical course: 6 SWS Lectures: 2 SWS	**Module window** Wintersemester, Fenster 3	**Group size** 16	**Duration** 1 semester

Learning outcomes/skills

At the end of the course, students will be able to analyze biological models that are described by differential equations. The course will focus on the qualitative analysis of one-, and multi-dimensional differential equations. The students will be able to predict the stability of dynamical systems, and relate this to physiological phenomena. The students will be able to use sensitivity analysis to understand how parameters affect solutions. The students will be able to use bifurcation analysis to understand how parameters can change the qualitative behavior of dynamical systems. The students will learn to work independently on a given topic, read and understand literature, and present their results in a mathematically comprehensible format.

Forms of teaching

Lectures and hands-on tutorials, presentations of exercises.

Content

The lectures will be composed of two sections:

- one dimensional differential equations
- multidimensional differential equations (focusing on two dimensional systems)

For each section, the following material will be covered:

- Linear stability analysis
- Local and steady state sensitivity analysis
- Bifurcation analysis (saddle node, transcritical, and pitchfork)
- Application to prototypical biological processes (gene regulation, ecological models, metabolism, etc.)

Exercises:

The theoretical foundations will be taught in the lectures before the practical courses. The exercises will serve to reinforce the theory introduced during the lectures, and demonstrate how it can be applied to real biological systems. At the end of the course, a short introduction to programming in the Julia language will be presented, so that the students will gain some familiarity with using a programming language to solve differential equations and confirm their qualitative analyses introduced during the course with simulations.

Eligibility

Formal: All modules of basic studies (1. – 4. Sem.) need to be completed

Content-related: Basic mathematical knowledge, basic experience in any programming language is helpful.
Examination types Learning portfolio consisting of: • Written exam on the content of the lectures and practical courses (60%) • Exercises (40%)
Requirements for the award of credit points for this course (1) Regular and active participation in lectures and practical courses (2) On-time submission of homework exercises, which must at least fulfill minimal standards (3) Passing the final examination
Relevant for following study programs/major Bachelor Biologie, Bachelor Quantitative Biologie, Bachelor Biologie International
Compatibility with other curricula
Significance of the mark for the overall grade The mark given will contribute to the final grade in proper relation to its credits. 9/170 CP (B.Sc. Biologie); 9/186 CP (B.Sc. Biologie International), 9/221 CP (B.Sc. Quantitative Biologie)
Course language ( ) German (x) English ( ) German and English ( ) German, English on demand
Additional information Registration via LSF https://lsf.uni-duesseldorf.de/