Module Guide

Master of Science
Biochemistry International

Heinrich-Heine-Universität Düsseldorf

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Qualification goals

The one-year master's programme Biochemistry International is intended to enable graduates of 4-year bachelor's degree courses from Germany and abroad to efficiently prepare for an independent scientific career.
Graduates of the programme are familiar with current research topics, especially in the identification and characterization of protein-mediated processes in nature and technology. The profile of the graduates lies in the characterization and application of enzymes using methods of molecular biology, biochemistry, biophysics and theoretical chemistry. The graduates have theoretical knowledge, methodological and system competence to independently recognize and solve complex problems at the current interfaces of chemistry and biology. They are able to plan, implement and convey research projects with a biomolecular scientific background.
The graduates are able to plan their professional development. With their degree, they have qualified to assume responsibility as a laboratory or project manager and have the potential to demonstrate their scientific qualifications in a doctorate. Important professional fields are in medical-pharmaceutical research, white, red and green biotechnology, quality control and quality management in the food industry, in public administration and life science research at universities and research institutes.

Outline of the programme

The master’s programme is offered by the departments of biology and chemistry of the HHU and the research centre Jülich ensuring a broad, top-level offer of current research topics. The programme comprises two semesters with 30 credit points each. In the first semester courses composed of lectures and practical training are chosen. Optional is a three-month research internship inside or outside of the university. The master’s thesis fills the second semester. The six-month research project is concluded by a written as well as an oral presentation. This module guide describes the courses devised for this programme. Other courses are eligible after consultation with the examination board.

Examinations and Credits

Modules regularly end with an oral or written examination. Successful students accumulate credit points according to the European Credit Transfer System (ECTS). The master’s degree requires 60 CP. The final grade is computed from the weighed average of all graded modules.
Credit points express the work load associated with the completion of a module with 1 CP corresponding to approximately 30 hours of work. Included are the hours spent in lectures and courses as well as the hours spent at home or in the library to prepare for the courses, to write reports and to prepare for the exams. The ratio between time of attendance and total work load differs between modules and has to be determined for each module. Evaluations of modules gather the work load reported by the students to check for a correct assessment.

Modules described in this guide are focused on those taught in English. Other modules offered by the departments of biology and chemistry are eligible as well. These include modules taught in German or taught in English only unsteady.

Advanced Fluorescence Imaging (CAI) (M4467)					Last updated: 6.7.2021
ECTS-Points	Workload [h]	Duration		frequency	
14	420	6 weeks		Winter term	

Course components	Type	Hours [PPW	Contact time [h]	Self-study [h]	Group size
Lecture	V	2	30	90	12
Practical	PExp	18	240	60	12

Responsible Lecturer	PD Dr. Y. Stahl	
Participating lecturers	S. Weidtkamp-Peters, Y. Stahl	
Language	English	
Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie	Elective

Educational objectives and skills

The students understand the theoretical basis of fluorescence and its describing parameters like anisotropy, fluorescence quantum efficiency and fluorescence lifetime and can describe the basic concepts of fluorescence microscopy. The students are able to perform state-of-the-art advanced fluorescence microscopic techniques (FCS, FRET, FLIM, FRAP) from sample preparation and image acquisition to data analyses in order to solve relevant biological questions, independently. In addition they understand and can apply advanced nanoscopic techniques (e.g. STED), as well as fast camera-based imaging techniques (e.g. spinning disk, light sheet microscopy). They can explain and compare the pros and cons of the different fluorescent techniques and are able to apply these techniques to solve different relevant biological questions and analyze and judge the results of their experiments.

Contents

Lecture: In the lectures the basics of light and fluorescence microscopy and their application in relevant biological questions are taught. This includes the fundamentals of fluorescence, the properties of fluorescence and how these are determined. Additionally, the setup of fluorescence microscopes and the different fluorescence microscopy techniques are discussed. The students will get to know different state-of-the-art microscopic techniques which employ fluorescence reporters in order to characterize the behaviour of proteins and biomolecules in cells and in vitro. Due to the content of the lectures, the students are supposed to understand and apply the theoretical fundamentals of these techniques to planning and performing of experiments during the practical part of the course.
Practical: The students will apply different fluorescence techniques to two different model systems (human cell lines and tobacco leaves) in order to investigate the properties of different cellular proteins. Using these model systems the students will get to the techniques for transient expression in tobacco leaves and transfection of human cell lines, as well as the following fluorescence microscopic experiments and their analyses. In the plant system, the students will be faced with various difficulties, e.g. autofluorescence and movement of cells during the measurements and due to their acquired theoretical background they should be able to find solutions to these problems independently. Additionally, the students will get to know distinct fluorescence techniques on human cell lines, e.g. indirect immunofluorescence. Using both biological systems, the students will learn how to use a confocal laser scanning microscope (CLSM) and the other advanced imaging microscopes to apply the theoretical knowledge in vivo. The students will analyze the acquired data using the appropriate software. Imaging data shall be prepared in a way that conclusions about localization in different cell types can be drawn; live cell experiment data shall allow conclusions about e.g. interaction and mobility of different proteins..

Prerequisites for participation	None		
Required performance while attending	Regular, active participation		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and evaluation	Type of Examination	Duration[min]	Weight in final grade
	Written examination	120	80%
	Scientific report		20%
Weight in degree grade	Weighted with 14 of appr. 50 graded CP or 28%		
Literature	provided at beginning		

Biogenesis and Transport of Membrane Proteins				Last updated: 31.8.2021
ECTS-Points	Workload [h]	Duration	Frequency	
8	240	3 weeks	Winter term	

Course components	Type	Hours [PPW]	Contact time [h]	Self-study [h]	Group size
Function and intracellular transport of ion channels	V	2	30	60	
Functional expression and visualization of a voltage-activated calcium channel complex	PExp	5	90	60	6

Responsible Lecturer	Prof. Dr. P. Hidalgo	
Participating lecturers	P. Hidalgo	
Language	Englisch	
Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie M.Sc. Chemie	Wahlpflicht

Educational objectives and skills

After successful completion of the course, the students know:

- the theory and methods of membrane protein biogenesis and intracellular transport.
- the importance of intracellular transport processes in health and disease.
- experimental strategies to study function and expression of ion channels.
- quantitative analysis of the protein movement inside the cell.

Contents

Lecture

Structure and function of voltage-activated ion channels, molecular mechanisms underlying biogenesis, intracellular transport and function of calcium channels.

Labwork

Expression of ion channels and current recordings using the „whole-cell patch clamp technique“ in cultured cells, fluorescence labelling of cytoskeletal filaments (tubulin and actin) and different components of the trafficking machinery, fluorescence labelling of purified proteins for microscale thermophoresis studies, live-cell imaging from cells expressing voltage-activated calcium channels using spinning-disc microscopy, and quantitative analysis of the intracellular movement of the channel complex, detection of heterologously expressed channel subunits in cytosolic and membrane-associated fractions by electrophoresis and fluorescence scanning.

Prerequisites for participation	Sound understanding of biophysical principles		
Required performance while attending	Regular, active participation in lab work; oral presentation of experimental results.		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and evaluation	Type of examination	Duration [min]	Weight in final grade
	Oral presentation	20	50%
	Written report	-	50%
Weight in degree grade	Weighed with 8 of about 100 graded CP or 16%		
Additional informations	HIS-LSF		
Literature	Actual reviews and original articles will be provided at the beginning of the course		

From gene to in silico structure– the use of protein data bases (ISS)					Last updated: 31.8.2021
ECTS-Points	Workload [h]	Duration	frequency		
5	150	2 weeks	winter term: in person - summer term: online		

Course components	Type	Hours [PPW]	Contact time [h]	Self-study [h]	Group size
Protein Data Bases	V	2	30	40	
From gene to in-silico structure	Ü	3	45	35	24

Responsible Lecturer	Dr. S. Smits	
Participating lecturers	S. Smits	
Language	Englisch	
Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie M.Sc. Biology International M.Sc. Chemie M.Sc. Wirtschaftschemie	Wahlpflicht

Educational objectives and skills

After completion of the module students

- have the ability to judge the outcome of web based analysis and to explain the advantages and the disadvantages of the programs used
- understand the possiblities of using internet programmes to identify DNA sequences in genomes, to analyse the proteins encoded, and to predict the function of these proteins.
- can perform a structural analysis of sequences, a prediction of protein structures and active site

Contents

Lecture: DNA sequencing, Identification of open reading frames, sequence alignments and datbases (How do these databases work, what are the advantages and disadvantages), FASTA and BLAST searches, Database for primary secondary and tertiary structure prediction using protein sequences Literature search using pubmed, Usage of databases to predict the function, diversity, homology, topology, modification of protein families and single proteins. Protein structure prediction as well as homology modeling and molecular simulations
Exercise: From DNA sequence to a homology model of the encoded protein; presentation of the results

Prerequisites for participation	None		
Required performance while attending	Sequence based prediction of structure and function of exemplary protein		
Prerequisites for admission to examination	None		
Examination and evaluation	Type of examination	Duration [min]	Weight in final grade
	Oral presentation	20	Not graded
Weight in degree grade	Not graded		
Additional informations	HIS-LSF		
Literature	References wll be provided for preparation; research in literature database will be performed during course work		

Integrative Topics in Cell Biology (M4461)					Last updated: 4.2.2019
ECTS-Points	Workload [h]	Duration		frequency	
14	420	1 Semester		WiSe	

Course components	Type	Hours [PPW]	Contact time [h]	Self-study [h]	Group size
Lecture	V	2	30	90	
Practical	PExp	18	240	60	16

Responsible Lecturer	Prof. Dr. M. Pauly	
Participating lecturers	H. Aberle, I. Axmann, P. Bauer, M. Beller, A. Buell, M. Feldbrügge, U. Fleig, S. Gould, T. Klein, N. Linka, M. Pauly, R. Simon, I. Span, Y. Stahl, A. Weber	
Language	English	
Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie	Elective

Educational objectives and skills

Students have learned the concepts and methods of modern cell biology and are capable of using them. They have adopted genetic, cellular, molecular biological and biochemical techniques and can apply these techniques independently. Students are familiar with the major scientific equipment and are capable of using the instruments precisely and independently. Students are able to work in teams.

Contents

Lecture:

Organization of the cell: Cell chemistry - Membrane structure and transport across membranes - Intracellular compartments and protein sorting – intracellular membrane trafficking – endosymbiosis - mitochondria and plastids – cell signaling – cytoskeleton

Cells in their social context: Cell junctions – extracellular matrix – stem cells – cell morphogenesis and growth – neural development – visualizing cells

Practical:

Molecular biology: e.g. DNA - and RNA isolation methods, vector construction, transformation of organisms, gel-electrophoresis, PCR

Cell biology: fluorescence microscopy

Biochemistry: e.g. immuno-localization and purification of proteins, analysis of enzyme kinetics and regulatory properties of proteins, carbohydrate analysis

The practical course will consist of research projects in the laboratories of the participating lecturers. The laboratory can be chosen according to the student's interest. The methods to be learned will depend on the research project.

Prerequisites for participation	None		
Required performance while attending	Regular, active participation		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and evaluation	Type of examination	Duration [min]	Weight in final grade
	Wwritten examination	120	70%
	Scientific report		30%
Weight in degree grade	Weighted with 14 of appr. 50 graded CP or 28%		
Additional informations	HIS-LSF		
Literature	Alberts "Molecular Biology of the Cell; primary literature provided for preparation		

Integrative Topics in Microbiology (M4452)					Last updated: 4.2.2019
ECTS-Points	Workload [h]	Duration		frequency	
14	420	1 semester		Winter term	

Course components	Type	Hours [PPW]	Contact time [h]	Self-study [h]	Group size
Lecture	V	2	30	90	
Practical	PExp	18	240	60	16

Responsible Lecturer	Prof. Dr. M. Feldbrügge
Participating lecturers	I. Axmann, M. Bott, M. Eisenhut, M. Feldbrügge J. Frunzke, S. Gould, J. Hegemann, K.-E. Jaeger, E. Nowack, H. Schaal, L. Schmitt, M. Zurbriggen
Language	English

Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie	Elective

Educational objectives and skills

Students have learned the concepts and methods of modern microbial science and are capable of using them. They have adopted genetic, molecular biological and biochemical techniques and can apply these techniques independently. Students are familiar with the major scientific equipment and are capable of using the instruments precisely and independently.

Contents

Lecture:
Microbial cell biology: Cell biology of eukaryotic microorganisms - Filamentous fungi - RNA biology - Membrane trafficking - From endosymbionts to cellular organelles - Cyanobacteria
Microbial pathogenicity: Chlamydia - Bacterial and fungal pathogens - Plant microbe interactions - Virology and splicing - Bacteriophages
Microbial biotechnology: Corynebacterium biology and applied sciences - Bacterial biotechnology and lipases - Lov domain proteins: bacterial sensing and signalling - Heterologous protein expression in fungi -
Structural biology and protein expression in *E. coli* – Cyanobacteria – Synthetic Biology
Practical: *The practical course will cover modern methods in molecular biology*:
e.g. DNA - and RNA isolation methods, fluorescence microscopy, gel-electrophoresis, PCR;
and biochemistry:
e.g. immuno-localization and purification of proteins, analysis of enzyme kinetics and regulatory properties of proteins.
The practical course will consist of research projects in the laboratories of the participating lecturers. The laboratory can be chosen according to the student's interest. The methods to be learned will depend on the research project.

Prerequisites for participation	None
Required performance while attending	Regular, active participation
Prerequisites for admission to examination	Successfull completion of lab work

Examination and evaluation	Type of examination	Duration [min]	Weight in final grade
	Written examination	120	70%
	Scientific report		30%

Weight in degree grade	Weighted with 14 of appr. 50 graded CP or 28%
Additional informations	HIS-LSF
Literatur	Provided for preparation

Integrative Topics in Plant Science (M4439)					Last updated: 1.6.2016
ECTS-Points	Workload [h]	Duration		Frequency	
14	420	1 semester		Winter term	

Course components	Type	Hours [PPW]	Contact time [h]	Self-study [h]	Group size
Lecture	V	2	30	90	16
Practical	PExp	18	240	60	16

Responsible Lecturer	Prof. Dr. A. Weber	
Participating lecturers	M. Feldbrügge, V. Göhre, G. Groth, P. Jahns, M. Lercher, N. Linka, S. Matsubara, M. Pauly, L. Rose, P. Bauer, R. Simon, A. Weber, J. Zeier, M. Zurbriggen	
Language	English	
Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie	Elective

Educational objectives and skills

Students have learned the concepts and methods of modern plant science and are capable of using them. They have adopted genetic, molecular biological and biochemical techniques and can apply these techniques independently. Students are familiar with the major scientific equipment and are capable of using the instruments precisely and independently.

Contents

Lecture:
Plant-pathogen interaction: The plant immune system; Polar growth in phytopathogens; Systemic acquired resistance in plants; Molecular evolution of a disease resistance pathway
Plant genomes, gene regulation and development: Comparative genomics and transcriptomics; Plant epigenetics – inheritance beyond the DNA sequence; The stem cell concept in plant development; Plant membrane proteins: Molecular motors, sensors and transmitters; Transcription factor networks involved in the regulation of metal uptake; Synthetic Biology – controlling and understanding of eukaryotic signaling processes and regulatory networks; Structure and function of the plant cell wall and it's use as renewable resource
Photosynthesis and plant metabolism: C4 photosynthesis – physiology, developmental biology and evolution; Photo-oxidative stress in plants; Carotenoids in plant stress response; Players, metabolic interactions and evolution of the photorespiratory pathway; Intracellular metabolite transport in plant cells; Peroxisome – a neglected, but important organelle for plant function
Practical: *The practical course will cover modern methods in molecular biology*:
e.g. DNA - and RNA isolation methods, fluorescence microscopy, gel-electrophoresis, PCR;
and biochemistry:
e.g. immuno-localization and purification of proteins, analysis of enzyme kinetics and regulatory properties of proteins.
The practical course will consist of research projects in the laboratories of the participating lecturers. The laboratory can be chosen according to the student's interest. The methods to be learned will depend on the research project.

Prerequisites for participation	None		
Required performance while attending	Regular, active participation		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and evaluation	Type of examination	Duration [min]	Weight in final grade
	Written examination	120	70%
	Scientific report		30%
Weight in degree grade	Weighted with 14 of appr. 50 graded CP or 28%		
Additional informations	HIS-LSF		
Literature	Provided at beginning		

Microbiology (M4405)					Last updated: 31.8.2021
ECTS-Points	Workload [h]		Duration		Frequency
14	420		6 weeks		summer term
Course components	Type	Hours [PPW]	Contact time [h]	Self study [h]	Group size
Lecture and Seminar	L/S	2	30	90	16
Practical	P	18	240	60	16
Responsible Lecturer	Prof. Dr. M. Feldbrügge				
Lecturers	M. Feldbrügge, J. Frunzke				
Language	English				
Applicability of module	Programme			Mode	
	M.Sc. Biochemie M.Sc Biochemistry International M.Sc. Biologie M.Sc. Biology International			Elective	

Learning outcomes and skills

Students deepen their theoretical and practical knowledge previously acquired in microbiologi- cal V-Modules. They are able to describe, apply and analyse the molecular biology of microor- ganisms of prokaryotic as well as eukaryotic origin. Students will be able to combine, explain, modify and analyse (protocol) information from the lecture and the practical course. Students will have learned to independently and accurately handle laboratory equipment and instru- ments. Thus, after completion of the course students will be in a position to competently apply techniques and methods currently used in microbiological research.

Contents

Lecture: Phylogeny, comparative genomics, microbial cell division, microbial, cell differentiation, horizontal gene transfer, protein secretion in bacteria and fungi, organelles and import mechanisms; protein modifications and folding; signal transduction pathways; transcriptional regulation, posttranscriptional regulation; pathogenic fungi; virulence mechanisms, actin and microtubule cytoskeleton, molecular transport of endosomes and mRNAs

Practical Course: Cloning strategies, gene amplification and (virtual) cloning of plasmids, protein tagging, immunofluorescence localization, biosensor design, transformation, gene disruption and expression profiling; construction and detection of reporter gene fusions/gene deletion in pathogenic fungi; DNA isolation, Southern blot, PCR methods, cell fractionation, SDS-PAGE, immuno blotting; vital stains, reporter proteins (GFP fusions), microscopy; data mining in electronic data bases and other internet resources for molecular and microbiology; live imaging of actin and microtubule cytoskeleton; recombinant protein production, purification

Prerequisites	Sound basic knowledge in microbiology		
Requirements	regular and active participation		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and grading	Type of examination	Duration [min]	Weight in module grade
	Written examination	120	60%
	Practical report		30%
	Review assignments on selected genes		10%
Weight in final grade	Weighted with 14 of appr. 50 graded CP or 28%		
Literature	Provided prior to course		

Molecular Biomedicine of Inner Organs (M4415)					1.6.2016
ECTS-Points	Workload [h]		Duration		Frequency
14	420		6 weeks		winter term
Course components	Type	Hours [PPW]	Contact time [h]	Self study [h]	Group size
Molecular Biomedicine	V	2	120	30	300
Practical	PExp	18	300	240	15

Responsible Lecturer	Prof. Dr. E. Lammert	
Lecturers	E. Lammert, D. Eberhard	
Language	English	
Applicability	Programme	Mode
	M.Sc. Biochemie M.Sc Biochemistry International M.Sc. Biologie M.Sc. Molecular Biomedicine	Elective

Learning outcomes and skills

Students learn the basic principles of organ development, physiology, cell biology and biomedicine using some selected organs and organ-based diseases. They learn how to independently plan and conduct experiments on medically relevant organs (such as the cardiovascular system) and perform a number of tissue- and cell-based technologies. The students can independently and precisely work with light microscopes, fine surgical tools, ELISA, real-time RT-PCR, gel documentation system and other modern instruments inside a state-of-the-art laboratory.

Contents

Lecture: The lectures are about the basics of biomedicine, development, physiologic function and human disease of selected organs and tissues. In addition, the lectures cover some in vitro and in vivo models for human diseases as well as tissue and cell culture techniques.
Practical Course: Students will perform state-of-the-art methods on cell biology, developmental biology, physiology and biomedicine of selected organs and tissues. The students will isolate embryos, islets of Langerhans as the key tissues involved in diabetes mellitus, and the liver under the stereomicroscope. They will generate cryosections of these important tissues, perform immunohisto- and cytochemistry, laser scanning microscopy (LSM), insulin secretion assays (ELISA) required for diabetes research, tissue culture, western blots, tissue- and cell culture techniques as well as software-based image analyses, statistics, and data documentation.

Prerequisites	Nnone		
Course achievements	Regular and active participation		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and grading	Type of examination	Duration [min]	Weight in module grade
	Written examination	120	70%
	Written report		30%
Weight in final grade	Weighted with 14 of appr. 50 graded CP or 28%		
Additional informations	https://www.stoffwechsel.hhu.de/lehre		
Literature	Provided at beginning		

Molecular Microbiology (M4401)					1.10.2018
ECTS-Points	Workload [h]	Duration	Frequency		
14	420	6 weeks	winter term		

Course components	Type	Hours [PPW]	Contact time [h]	Self study [h]	Group size
Lecture and Seminar	L/S	2	30	90	12
Practical	P	18	240	60	12

Responsible Lecturer	PD Dr. U. Fleig	
Lecturers	U. Fleig, J. Hegemann	
Language	English	
Applicability	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie M.Sc. Biology International	Elective

Learning outcomes and skills

The aim of this course is to introduce the student to two topics: eukaryotic microorganisms (model yeasts) and prokaryotic bacterial pathogens (human pathogenic *Chlamydiae*). Part 1: Knowledge and understanding of the main pathogenicity mechanisms of human pathogens; knowledge and understanding of the infection cycle of *Chlamydiae*. Part 2: Knowledge about genetic and molecular biological processes in fungi. Knowledge about the structure and function of microbial genomes. Description and elucidation of the yeasts *S. cerevisiae* and *S. pombe* as eukaryotic model systems concerning cell cycle, aneuploidy, ageing, cell morphogenesis and fungal pathogenicity. The students are able to recite, explain and comment on the content of the lectures and understand the methods used during the practical course. Students will be able to design and carry out experiments independently and draw their own conclusions.

Contents

Lecture: -Functional genome analysis of bacteria and yeasts.
Yeasts as eukaryotic model systems for (i) functional characterisation of bacterial human pathogenic effector proteins, (ii) cell division and cell cycle of prokaryotic and eukaryotic microorganisms (chromosome segregation, meiosis), (iii) ageing, (iv) cell morphogenesis.
Pathogenicity mechanisms in human pathogenic agents: infection cycles and diseases; molecular reciprocation between bacterium and host cell; secretion systems; pathogenicity mechanisms. Example, chlamydia: life cycle; diseases; adhesins, receptors; effector proteins.
Seminar: each student will read a subject-related publication and present the main results of this publication orally.
Practical: Microbial genomics: Using databases: sequence analyses, literature searches, prediction programs (e.g. secondary structural analyses).
Microscopic analysis of the chlamydia infection cycle; expression and affinity purification of specific chlamydial proteins; analysis of the binding capacity of such proteins to human cells. Ectopic expression of chlamydial proteins in yeast and human cells and analysis of phenotypic consequences.
Gene tagging in yeast: targeted chromosomal gene manipulation (deletion, mutation, tagging) in *S. cerevisiae* or *S. pombe* using homologous recombination; verification of correct genomic integration (PCR, southern blots); analysis of biological phenotypes. Determination of protein-protein interaction using different methods: yeast-2-hybrid system; co-immunoprecipitation of epitope-tagged proteins, genetic suppressor analysis. Use of reporter proteins for subcellular protein localisation in yeasts, qualitative and quantitative proof of gene expression in yeasts using reporter proteins (e.g. ß-galactosidase, GFP).
Yeasts as eukaryotic model systems for chromosome segregation/aneuploidy, cell ageing, morphogenesis and characterisation of bacterial effector proteins.

Prerequisites	None
Requirements	Regular and active participation
Prerequisites for admission to examination	Successfull completion of lab work

Examination and grading	Type of examination	Duration [min]	Weight in module grade
	Written examination	120	75%
	Scientific practical report		10%
	Oral presentation	15	15%

Weight in final grade	Weighted with 14 of appr. 50 graded CP or 28%
Literature	Provided at beginning

Physics and Biology of Protein Folding in Cellular Membranes				Stand: 31.8.2021
ECTS-Points	Workload [h]	Duration	frequency	
8	240	3 Wochen	SoSe	

Course components	Type	Hours [PPW	Contact time [h]	Self-study [h]	Group size
Lecture	V	3	45	90	
Lab work	PExp	5	75	30	12

Responsible Lecturer	Prof. Dr. A. Kedrov	
Participating lecturers	A. Kedrov	
Language	Englisch	
Applicability of module	Programme	Mode
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie M.Sc. Chemie	Wahlpflicht

Educational objectives and skills

After successfull completion of the modul students are able to

- explain the physical and biochemical rules for membrane protein folding.
- describe methods applied in analysis of membrane protein folding and stability.
- isolate components of sec locon and ribosomes, reconstitute the components and determine their functional properties.

Contents

Lecture

Thermodynamics of MP folding; protein:protein and protein:lipid interactions; biophysical analysis of MP folding; spontaneous insertion in biology; MP targeting in bacteria and eukaryotes; structure and dynamics of Sec and YidC-type insertases; folding in bacterial outer membranes; tail-anchored proteins; folding in mitochondria and peroxisomes; membrane protein misfolding and degradation, ERAD; designing de novo membrane proteins, macromolecular crowding in membranes.

Lab work

Isolation and liposome/nanodisc reconstitution of the Sec:YidC machinery; analysis of Sec-mediated protein translocation; isolation of ribosome:nascent chain complexes (RNC); studying RNC:signal recognition particle or RNC:Sec/YidC interactions; analysis of nascent chain contacts by chemical cross-linking; purification and analysis of MP intermediates.

Methods: bacterial cell culture, membrane isolation, chromatography-based purification, SDS-PAGE & western blotting, ATPase assay, ultra- and zonal centrifugation, fluorescence spectroscopy assays, incl. Förster's resonance energy transfer-based kinetic measurements, cell-free protein synthesis and assembly.

Preparing and presenting a publication on a relevant topic.

Prerequisites for participation	Sound understanding of biophysical principles		
Required performance while attending	Regular, active participation; preparation of a lab report		
Prerequisites for admission to examination	Successfull completion of lab work		
Examination and evaluation	Type of examination	Duration [min]	Weight in final grade
	Written examination	30	70%
	Oral presentation	30	30%
Weight in degree grade	Weighted with 8 of appr. 50 graded CP or 16%		
Additional informations	HIS-LSF		
Literature	List of references provided for preparation		

Research Internship					31.8.2021	
ECTS-Points	Workload [h]		Duration		Frequency	
15	450		3 month		summer or winter term	
Course components	Type	Hours [SWS]	Contact time [h]		Self study [h]	Group size
Internship	Project		350		100	1
Responsible lecturer	Chair of examination board					
Participating lecturers	All lecturers of the faculty of mathematics and natural sciences					
Language	English or German					
Applicability	Programme				Mode	
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie M.Sc. Biology International M.Sc. Chemie M.Sc. Wirtschaftschemie				Elective	
Learning outcomes and skills						
Practical experience in the handling of current research tasks or the application of scientific results; integration and active participation in scientific team work; ability for the planning, performance and presentation of research projects						
Contents						
Current research topics in chemistry, biology, molecular medicine and the application of scientific results						
Prerequisites	None					
Requirements	Regular and active participation					
Examination and grading	Type of examination		Duration [min]		Weight in module grade	
	Scientific project report				no grade	
Weight in final grade	None					
Literature	Current reviews and primary literature are provided for preparation; active literature work is also part of the internship					

Master's Thesis					31.8.2021	
ECTS-Points	Workload [h]		Duration		Semester	
30	900		6 month		2	
Course components	Type	Hours [SWS]	Contact time [h]		Self study [h]	Group size
Master seminar	S	1	15		45	20
Master thesis	Project		640		105	1
Responsible Lecturer	Chair of examination board					
Lecturers	All lecturers of the faculty of mathematics and natural sciences; for master theses conducted outside of the faculty of mathematics and natural sciences at least one of the examiners has to be a member of this faculty.					
Language	English					
Applicability	Programme				Mode	
	M.Sc. Biochemie M.Sc. Biochemistry International M.Sc. Biologie M.Sc. Biology International M.Sc. Chemie M.Sc. Wirtschaftschemie				Compulsory	
Learning outcomes and skills						
Capability to independently pursue a scientific objective in molecular biosciences; competence to comprehend scientific questions, to perform targeted literature research, to devise a meaningful approach; expertise in the planning and performance of experiments; ability to active participation in a team, oral and written presentation of scientific work; English language skills						
Contents						
Current research topics in chemistry, biology and molecular medicine						
Prerequisites	30 credit points earned in programme					
Requirements	Regular and active participation in seminar and group meetings					
Examination and grading	Type of examination		Duration [min]		Weight in module grade	
	Written master thesis		-		80%	
	Oral presentation (English)		20		20%	
Weight in final grade	Weighted with 30 of appr. 50 graded CP or 60%					
Literature	Current reviews and primary literature					