Module guide
for the M.Sc. degree course
Biochemistry and Biophysics
Faculty of Chemistry and Pharmacy and Faculty of Biology at
Albert-Ludwigs-University of Freiburg
**Introductory remarks**

This is a guide for the M.Sc. degree course Biochemistry and Biophysics. It contains general information on the program and an overview of its structure and schedule. The main part is the module catalog which contains details of all courses that are part of the modules.

The module guide was written with great care and offers a wealth of information which is easy to understand. However, completeness and answers to all questions cannot be guaranteed. In case you have any questions that are not answered in the guide, do not hesitate to contact the people that are listed in the appendix; amendments are appreciated as well.

The use of both male and female forms is omitted in favor of readability. References to any gender include all genders.

Effective January 2017
1. **Interdisciplinary M.Sc. degree course Biochemistry and Biophysics**

The main idea of biochemistry is to study the molecular bases of living systems. Biochemistry offers a fascinating scientific diversity; from analyzing chemical structures in nature to investigating biological functions. Originating from the study of metabolic reactions, enzymology and energetics, modern biochemistry has split into many different and to some extent technology-oriented fields.

The fundamental principles to understand molecular functions of proteins, nucleic acids, carbohydrates and lipids are elucidated using methods of structural analysis, such as protein crystallography, magnetic resonance spectroscopy and mass spectrometry. Together with molecular biology techniques, these methods provide detailed insight into mechanisms of enzymatic catalysis, energy metabolism, signal transduction and intercellular communication.

The M.Sc. degree course Biochemistry and Biophysics is a consecutive, research oriented course of four semesters leading to a Master’s degree. Based upon bachelor degree programs in biochemistry, biophysics, life sciences, pharmaceutical sciences, biology, chemistry and molecular medicine, this interdisciplinary course provides a specialized education in biochemistry, biophysics, bioinformatics and bioengineering.

The description of protein function at a molecular level represents the main content of the M.Sc. degree course Biochemistry and Biophysics.

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**Subject-specific targets**

- Graduates are capable of conceiving basic scientific, especially biochemical and biophysical, problems and issues. They are able to plan and execute experiments to answer scientific questions. Based on the knowledge obtained in a bachelor’s degree course, the students acquire additional skills and know-how which enables them to develop solutions even in situations where the currently available methods are not
sufficient. Interdisciplinary experimental methods and applications are considered as important tools to do so.

- Graduates will have deepened their knowledge in biochemistry, biophysics, bioinformatics microbiology or applied biosciences according to the current state of research. They are able to understand contemporary scientific publications, challenge the results of their own work and that of others and present them to an audience. The M.Sc. degree course Biochemistry and Biophysics is designed to provide graduates with the necessary basics to continue their education with doctoral studies on a high international level.

**Interdisciplinary qualification targets**

- Within the M.Sc. degree course, students are introduced to scientific research: They are supposed to challenge scientific publications and results and handle them responsibly.

- The students acquire ethical skills regarding general and subject-related principles of righteous scientific work and good practice (avoiding plagiarism, transparent documentation of data, etc.).

- Due to the interdisciplinarity of biochemistry and biophysics, graduates are able to work their way into related subjects and they are capable of collaborating with researchers working in related fields.

- Based on their expertise in different fields of biochemistry and biophysics, graduates are able to successfully apply scientific methods in order to solve complex problems in research and development, in industry as well as in research facilities. They are also able to challenge methods and refine them if necessary.
2. National and international variants of M.Sc. Biochemistry and Biophysics

National track:

The following modules are offered within the M.Sc. degree course Biochemistry and Biophysics: Biochemistry, Biophysics, Bioinformatics, modules from Biology I and II in one of the three core areas quantitative methods, genetics and developmental biology or biochemistry and microbiology, and methods and concepts courses.

The course consists of three parts: The first two semesters focus on the basics of research in various areas of biochemistry and biophysics and on deepening knowledge in these fields. The aim of the third semester is to create a scientific profile: Two lab courses, namely research training ("Forschungspraktikum") and master lab course - advanced ("Vertiefungspraktikum"), will deal with state-of-the-art research and prepare candidates for working on their master thesis. In the fourth semester, the master thesis is completed, working on an independent project in a research lab.
International track:

In the binational variant of the M.Sc. degree course Biochemistry and Biophysics – Biophysicochimie – the first semester has to be completed at the University of Strasbourg and the second at the University of Freiburg. For the third semester, students may choose between a lecture-oriented education at the University of Strasbourg and a practice-oriented education at the University of Freiburg. Depending on the choice for the third semester, the master thesis has to be completed at the other university in the fourth semester.
3. How to read and understand a module description

This example is to explain the layout of a module description and the terms that are used.

Module

Biochemistry

Department = university department(s) organizing this module

Recommended semester: 1. + 2. FS

15 ECTS CP

Name of the module

Number of Credit Points you get for completing this module, 1 ECTS Credit Point corresponds to a workload of 30 h (contact time + self-study) – no matter if it is for a lecture, lab course or exercises.

Here you find the list of all courses offered within this module and their properties (explanation below the table)

<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>Workload</th>
<th>Workload</th>
<th>P/WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Advanced Biochemistry</td>
<td>VL</td>
<td>60 h</td>
<td>60 h</td>
<td>P</td>
<td>4</td>
</tr>
<tr>
<td>b. Molecular Enzymology</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>c. Membrane Biochemistry</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>d. Bioinorganic Chemistry</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>e. Bioenergetics</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>f. Signal Transducing Cascades</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>g. Ringvorlesung</td>
<td>VL</td>
<td>60 h</td>
<td>60 h</td>
<td>P</td>
<td>4</td>
</tr>
<tr>
<td>h. Oberseminar Biochemie</td>
<td>S</td>
<td>30 h</td>
<td>30 h</td>
<td>P</td>
<td>2</td>
</tr>
</tbody>
</table>

Type:
VL – lecture („Vorlesung“)
Üb – excercise („Übung“)
Pr – lab course („Praktikum“)
S – seminar („Seminar“)

P/WP:
P – mandatory course („Pflichtkurs“)
WP – elective course („Wahlpflichtkurs“)

SWS („Semesterwochenstunden“):
Hours of contact time per week (only during the part of the semester in which lectures take place, not during the semester break)

Responsible person
Prof. Dr. T. Friedrich

Teachers
The lecturers at the institutes of Biochemistry (chemical department), Biology and Pharmacy

Recurrence frequency
a.-f. every WS
Letters are referring to the numbering in the list of courses; WS = winter semester, SS = summer semester

g.-h. every SS

Language
German or English
„or“ means it is individually decided by each lecturer

Requirements
The lab course in … has to be passed before.

In case of doubt, ask your teacher if it is possible for you to take part in a particular course.

Goals
Here you will find a description of what you should learn by completing this module.

Contents
Here you will find a summary of the topics of each course.
### Required Achievements and Exams

- a.-f. lectures without obligation to attend
- **PL:** oral exam on the content of lectures a. – f.

The oral exam may be taken as soon as lectures a.-f. are completed and should be taken before the start of the third semester.

Successful completion of the module “Biochemistry Lab Course” is required before taking the oral exam.

### Literature

For some courses, you will find information on recommended textbooks and on scripts you will receive.

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<table>
<thead>
<tr>
<th>Exams („Prüfungsleistungen“, <strong>PL</strong>)</th>
<th>final exam that is required to complete the module; this can be a written or oral exam, a graded report or lab course, etc. or a combination of these</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievements („Studienleistungen“, <strong>SL</strong>)</td>
<td>anything that is not graded but also needed to complete the module, e.g. a certificate of attendance</td>
</tr>
</tbody>
</table>

Here you find information on what is required to successfully complete the module, and, in some cases, further information on that. This one, for example, means that you don’t have to attend every lecture, but you are supposed to know the content.
4. Module descriptions

<table>
<thead>
<tr>
<th>Module</th>
<th>Biochemistry I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>Biochemistry (chemical department)</td>
</tr>
<tr>
<td>Recommended semester:</td>
<td>1. FS</td>
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<tr>
<td></td>
<td>9 ECTS CP</td>
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<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>Workload</th>
<th>Workload</th>
<th>P/ WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Advanced Biochemistry</td>
<td>VL</td>
<td>60 h</td>
<td>60 h</td>
<td>P</td>
<td>4</td>
</tr>
<tr>
<td>b. Molecular Enzymology</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>c. Membrane Biochemistry</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>d. Bioinorganic Chemistry</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>e. Signal Transducing Cascades</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
<tr>
<td>f. Bioinorganic Chemistry – Reaction Mechanisms and Model Compounds</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
</tbody>
</table>

**Responsible person**  
Prof. Dr. T. Friedrich

**Teachers**  
The lecturers at the institutes of Biochemistry (chemical department), Biology and Pharmacy

**Recurrency frequency**  
a.-f.: every WS

**Language**  
German/English

**Requirements**  
None

**Goals**

**Contents**

a. **Advanced Biochemistry**  
Chemistry of nucleic acids; structure of DNA; replication, transcription; gene expression and translation in prokaryotes and eukaryotes; structure and function of lipids; biosynthesis of membrane components; assembly and structure of the membrane; chemical structure of carbohydrates; classes of carbohydrates; glycoproteins; glycolipids; sugar metabolism; biosynthesis of sugars; structure and function of amino acids; biosynthesis and degradation of amino acids; structure and function of protein cofactors.

b. **Molecular Enzymology**  
Enzyme classification; enzyme specificity; active site characteristics; mechanistic models for enzyme catalysis: the lock-and-key, induced fit and strain or transition state stabilization models; kinetic and bioenergetic concepts of enzyme catalysis; activation energy, collision theory, order and molecularity of a reaction, reaction rate, rate constant, equilibrium constant, initial velocity; Henri and Michaelis-Menten equation; Briggs-Haldane equation; \( K_m, V_m, K_{cat} \); Lineweaver-Burk plot; Eady-Hofstee and Hanes plot; Eisenthal and Cornish-Bowden plot; Haldane relationship for reversible reactions; rapid, pre-steady state and relaxation kinetics; King and Haldane concept; reversible and irreversible enzyme inhibition; competitive, uncompetitive, non-competitive, mixed, partial, substrate, allosteric and irreversible inhibition models; kinetics of single- and multi-substrate enzyme reactions: ping-pong bi-bi mechanism.

c. **Membrane Biochemistry**  
Membrane-organism-organelle variability; Membrane composition, structure, function; Membrane assembly, fusion, fission; Membrane proteins; Artificial membrane systems. Optical, confocal and electron microscopy (SEM, TEM, Cryo-EM, Freeze-fracture, Tomography); Fluorescence Microscopy; FRET, Förster resonance energy transfer; FRAP, Fluorescence recovery after photobleaching; AFM, Atomic force microscopy; Detergents in membrane protein extraction and purification; CD, Circular dichroism; Dynamic Light
scattering; X-ray crystallography; SAXS, Small angle X-ray scattering; (Proteo)liposomes; Electrophysiology techniques: Planar lipid bilayer, Patch clamp; 2-electrode voltage clamp; Solid supported membrane-based electrophysiology; CIC channels; Electron paramagnetic resonance; Site-directed spin labeling.

d. **Bioinorganic Chemistry**
Biological metal clusters; principles of bioinorganic chemistry; iron, copper, molybdenum and nickel in biological systems; spectroscopic methods; important metalloproteins; reaction sites and mechanisms of metalloenzymes.

e. **Signal Transducing Cascades**
Signaling molecules; agonists, antagonists; paracrine, endocrinic, autocrinic signaling; receptor types (cell-surface and nuclear receptors): G protein-coupled receptors, ligand-gated ion channels, receptor tyrosine kinases, two-component signal transduction (histidine kinases and response regulators), intracellular receptors; signal sensing, transduction, amplification and desensitization events; effector molecules (adenylate cyclase, phospholipases, phosphodiesterases, kinases, ion channels, adenylyltransferases, diguanylate cyclase, G-proteins, Ras proteins), second messengers (cAMP, c-di-GMP, cGMP, DAG, Ca\(^{2+}\), IP3); vision and rhodopsin; neural synapses and neuromuscular communication: action and graded potentials; bacterial chemotaxis and phototaxis.

f. **Bioinorganic Chemistry – Reaction Mechanisms and Model Compounds**
Metal centres: bioavailability, Pourbaix diagrams, ligand exchange, complex stabilities; ligands: amino acids, nucleobases, porphyrin systems; design principles for synthetic model compounds; transport, storage and signalling proteins: ferrichrome, ferritin, hemoglobin, calmodulin, zinc finger; proteins for electron transfer: cytochromes, Fe/S-Cluster, type I copper proteins; metalloenzymes: hydrogenase, P450, sulphite oxidase, Zn-peptidase, tyrosinase, catalase, vitamin B12; interaction of metal ions with DNA / RNA; pharmaceutical applications of synthetic coordination compounds: cis-platin, \(^{99m}\)Tc-based radiopharmaceuticals, Gd-MRI contrast agents, \(^{18}\)F for PET; principles and model systems for the biomineralization of CaCO\(_3\), SiO\(_2\) and Ca\(_5\)[(PO\(_4\))\(_3\)](OH)\(_3\)]

**Achievements and Exams**

a.-f. lectures without obligation to attend

PL: oral exam on the content of lectures a.-f

The oral exam may be taken as soon as lectures a.-f. are completed and should be taken before the start of the third semester.

Successful completion of the module “Biochemistry Lab Course” is required before taking the oral exam.

**Literature**
Module

Biophysics

Physical Chemistry, Biochemistry (chemical department) and Microsystems Engineering

Recommended semester: 1. FS

<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>Workload</th>
<th>Workload</th>
<th>P/ WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cell Biophysics/&quot;Biophysik der Zelle&quot;</td>
<td>VL</td>
<td>45 h</td>
<td>75 h</td>
<td>P</td>
<td>3</td>
</tr>
<tr>
<td>b. Cell Biophysics/&quot;Biophysik der Zelle&quot;</td>
<td>Ü</td>
<td>30 h</td>
<td>30 h</td>
<td>P</td>
<td>2</td>
</tr>
<tr>
<td>(this exercise is awarded with 2 ECTS CP for the module „Methods and Concepts“)</td>
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</tr>
<tr>
<td>c. Modern Spectroscopic Methods in Biophysics</td>
<td>VL</td>
<td>30 h</td>
<td>30 h</td>
<td>P</td>
<td>2</td>
</tr>
<tr>
<td>d. Protein Crystallography I</td>
<td>VL</td>
<td>30 h</td>
<td>30 h</td>
<td>P</td>
<td>2</td>
</tr>
<tr>
<td>e. Single molecule methods</td>
<td>VL</td>
<td>15 h</td>
<td>15 h</td>
<td>P</td>
<td>1</td>
</tr>
</tbody>
</table>

Responsible person

Prof. Dr. Alexander Rohrbach, Prof. Dr. T. Hugel und PD. Dr. E. Schleicher

Teachers

The lecturers at the Department of Microsystems Engineering and at the Institute of Physical Chemistry

Recurrency frequency

every WS

Language

German/English

Requirements

None

Goals

The lectures give an overview of modern cell biophysics, spectroscopic methods and current research topics. This includes classical, but also contemporary, physical models and theories which, in combination with sophisticated methods of measurement, enabled significant progress in biophysics. The applied physical methods do not only stimulate biology and medicine, but also physics of complex systems which reaches a unique level of self-organization and complexity in the cell.

The exercises are designed to consolidate and deepen the content of the lecture. Transferring knowledge to other fields and using it to solve new problems and issues will be practiced in particular. Exercises will be handed out once a week, the students will process them and present the results on the blackboard. Difficult exercises will be explained by the tutor.

Contents

Cell biophysics/"Biophysik der Zelle"

1. Structure and composition of the cell or „The recipe for cellular biophysical research"
2. Diffusion and fluctuations
3. Measuring and manipulative techniques
4. Biologically relevant forces
5. Biophysics of proteins
6. Polymer physics
7. Viscoelasticity and micro rheology
8. Dynamics of the cytoskeleton
9. Molecular motors
10. Membrane physics

Knowledge of the following mathematical methods is an advantage:

- Taylor expansion; linear and stochastic differential equations; complex Fourier transformation; autocorrelation functions and their Fourier transform; the energy spectral density; probability density and combinatorics; multidimensional integrals and convolution.

Cell Biophysics/"Biophysik der Zelle" - Exercises
Exercises cover the mathematical methods that are part of the lecture Cell Biophysics.

**Modern Spectroscopic Methods in Biophysics**
1) Introduction to spectroscopic techniques
2) Vibrational spectroscopy of proteins
3) Time-resolved spectroscopy
4) Measurement of molecular interactions
5) Single molecule spectroscopy
6) Mößbauer spectroscopy
7) X-ray spectroscopy
8) Introduction to magnetic resonance spectroscopy
9) Solid state NMR
10) EPR spectroscopic distance measurements

**Protein crystallography**
Crystal growth, crystal symmetry, X-radiation, diffraction, structure factors, electron density maps, phase problem, anomalous scattering, methods to solve protein structures; model building and refinement; quality and validation of structures.

**Single molecule methods („Einzelmolekülmethoden“)**
1. Magnifier, microscope, resolution capacity
2. Fluorescence spectroscopy, spectrofluorometer
3. Super-resolution spectroscopy (STED, PALM)
4. Fluorescence Correlation Spectroscopy (FCS)
5. FRET
6. Single molecule kinetics
7. Surface Plasmon Resonance (SPR)

**Achievements and Exams**
SL: mandatory attendance of lecture a. and exercises b.
PL: written exam on the contents of lectures a., c., d., e.

**Literature**
Zachmann/Jüngel: Mathematik für Chemiker
Vogt: Grundkurs Mathematik für Biologen
Joe Howard: Mechanics of Motor Proteins and the Cytoskeleton
Gary Boal: Mechanics of the Cell
Rob Phillips: Physical Biology of the Cell
Erich Sackmann: Lehrbuch der Biophysik

Joseph R Lakowicz: Principles of Fluorescence Spectroscopy

Lecture notes with defined gaps (empty boxes) are provided for Cell Biophysics /“Biophysik der Zelle“
Module | Biochemistry Lab Course
---|---
Department | Biochemistry (chemical department)
Recommended semester: | 1. FS

<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>P/ WP</th>
<th>SWS</th>
</tr>
</thead>
</table>
a. Biochemistry Lab Course | Pr | 125 h | 55 h | P | 5 |

**Responsible person**
Dr. D. Wohlwend

**Teachers**
The lecturers at the institute of Biochemistry

**Recurrency frequency**
every WS

**Language**
German/English

**Requirements**
None

**Goals**
The students are able to challenge and comment on selected biochemical topics. They put modern techniques of molecular biology, microbiology and protein biochemistry into practice by applying them in the lab. In addition, the students acquire knowledge in redox biochemistry, UV vis spectroscopy and determination of three-dimensional protein structures by X-ray crystallography.

**Contents**
Biochemistry Lab Course
- Molecular biology (manipulation of DNA, cloning, PCR)
- Microbiology (cultivation of microorganisms, sterile techniques)
- Protein biochemistry (protein preparation techniques, protein analytics, such as redox titrations, ThermoFluor assays, UV/vis spectroscopy)
- X-ray crystallography (diffractometry, data handling, structure analysis)

**Achievements and Exams**
SL: attendance is mandatory
PL: graded protocols

**Literature**
Module: Bioinformatics

Department: Pharmaceutical sciences

Recommended semester: 1. FS

ECTS CP: 6

Courses

<table>
<thead>
<tr>
<th>Type</th>
<th>Contact Time</th>
<th>Self-Study</th>
<th>P/WP</th>
<th>SWS</th>
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</thead>
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<tr>
<td>VL</td>
<td>30 h</td>
<td>30 h</td>
<td>P</td>
<td>2</td>
</tr>
<tr>
<td>Ü</td>
<td>45 h</td>
<td>45 h</td>
<td>P</td>
<td>3</td>
</tr>
</tbody>
</table>

a. Advanced Methods of Bioinformatics
b. Molecular Modeling (Exercises related to lecture a.)

Responsible person: Jun. Prof. Dr. S. Günther

Teachers: The lecturers at the institute of pharmaceutical sciences.

Recurrency frequency: every WS

Language: German/English

Requirements: None

Goals: Acquisition of profound knowledge and understanding of methods that are used in bioinformatics and systems biology for integration of biomedical data, modeling molecular mechanisms and interactions, network analysis and evaluation of genetic markers.

Contents: Bioinformatical methods for integration of data, systems biological view of pathogenesis, modeling of pathogenic protein-protein interactions, evaluation of medical genomic data, pharmacogenomics, modeling the impact of small molecules on a metabolic and on a molecular level in complex diseases.

Achievements and Exams:
SL: attendance of exercises b. and submission of protocols is mandatory.
PL: written exam on the content of lecture a.

Literature:
PLOS Computational Biology: Translational Bioinformatics
Module Biology I

Department Biology

Recommended semester: 2. FS

12 ECTS CP

<table>
<thead>
<tr>
<th>Modules</th>
<th>Type</th>
<th>Workload</th>
<th>P/W</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is mandatory to choose one of the following elective modules:</td>
<td></td>
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</tr>
<tr>
<td>a. Quantitative Methods in Translational Biology (min. 6 participants)*</td>
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<tr>
<td>b. Genetics &amp; Developmental Biology (min. 4)*</td>
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<tr>
<td>c. Microbiology and Systems Biochemistry (min. 10)*</td>
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<tr>
<td>d. Advanced Biochemistry and Biophysics of Proteins&quot;(max. 8)*</td>
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</tbody>
</table>

* at least the given minimum number of students will be accepted for courses a.-c., course d. is limited to a maximum of 8 participants

Responsible persons

a. Prof. W. Weber
b. Prof. W. Neubüser
c. Prof. M. Boll
d. Prof. T. Friedrich

Teachers

Recurrency frequency The first 6 weeks of every SS (block course)

Language German/English

Requirements The module „Biochemistry Lab Course“ has to be passed before

Goals

Contents See the individual descriptions of the major modules in biology on the following pages.

Achievements and Exams

Literature

Note: The modules described on the following pages are major modules ("Schwerpunktmodule") for students in the M.Sc. program in biology, this is why the corresponding terms and abbreviations (SP1) are used in this module guide as well as in the course catalog. For students in the Biochemistry and Biophysics program, they are elective modules that may be chosen as module "Biology I".
Module: Biology I - Quantitative Methods in Translational Biology

Schwerpunktmodul I (M.Sc.) SP1-01

Responsible person: Weber, Wilfried
Department(s): Biochemistry (Department of Biology)

Type: elective module
Recommended semester: 2. FS

Duration: 1 semester, block course
ECTS: 12

Recurring frequency: each summer semester
Workload: 360 h

Recommended qualification: M.Sc. Biologie, Schwerpunkt Angewandte Biowissenschaften

M.Sc. Biochemistry and Biophysics, as elective module Biology I

Applicability:*

*indicates, in which program(s) the module can be used

Requirements:

Teachers: Drepper, Friedel / Eimer, Stefan / Masselter, Tom / Oeljeklaus, Silke / Speck, Thomas / Warscheid, Bettina / Weber, Wilfried

The courses within this module (lecture, exercise and seminar) are taught in German language. Accordingly, the following descriptions are given in German:

### Veranstaltungstitel

<table>
<thead>
<tr>
<th>Veranstaltungstitel</th>
<th>Lehrform</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative Methoden Schwerpunkt Translationale Biologie</td>
<td>Vorlesung</td>
<td>2</td>
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<td>60 h</td>
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<tr>
<td>Quantitative Methoden Schwerpunkt Translationale Biologie</td>
<td>Übung</td>
<td>7</td>
<td>5</td>
<td>210 h</td>
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<tr>
<td>Quantitative Methoden Schwerpunkt Translationale Biologie</td>
<td>Seminar</td>
<td>3</td>
<td>2</td>
<td>90 h</td>
</tr>
</tbody>
</table>

### Lernziele / Lernergebnisse

Die Studierenden
- können in der Programmiersprache „Python“ einfache Programme erstellen zur
  - numerischen Lösung von Differentialgleichungen
  - zur automatisierten Analyse von DNA- und Proteinsequenzen
- können die Dynamik in einfachen genetische Netzwerke mit Differentialgleichungen beschreiben und numerisch simulieren
- können die Vor- und Nachteile von Methoden zur quantitativen Proteomanalyse erläutern und sind in der Lage, grafische Darstellungen von Ergebnissen zu verstehen und zu beurteilen.
- können Datenreihen mit vorgegebenen Funktionen analysieren und grafisch darstellen. Aus den Ergebnissen können sie Schlussfolgerungen zum Verständnis von zellulären Signalprozessen ziehen.
- können die Formeln zur Berechnung der wichtigsten Materialkenngrößen (Flächenträgheitsmomente, Zug-, Druck- und Biegeeigenschaften, kritische Knicklängen) und des Wasserferntransportes bei Pflanzen herleiten und anwenden.
- sind in der Lage, die Evolution der Achsenanatomie und Wasserleitung bei Pflanzen auf dem Hintergrund dieser Berechnungen zu diskutieren.

### Studienleistung

- Regelmäßige Teilnahme an den Vorlesungen (1 Fehltag möglich)
- Vorstellung eines Seminarvortrages
- Bearbeitung der Hausaufgaben der Übungen.

### Prüfungsleistung & Benotung

- Mündliche Prüfung (ca. 30 Minuten) am Ende des Moduls: 75% der Note
- Eine benotete Hausaufgabe pro Themenbereich: 25% der Note

### Literatur

Wird zu Beginn des Moduls zur Verfügung gestellt
**Veranstaltungstitel:** Quantitative Methoden Schwerpunkt Translationale Biologie  

**Lehrform:** Vorlesung  

**Modul:** Schwerpunktmotu „Quantitative Methoden Schwerpunkt Translationale Biologie“  

**Verwendbarkeit:** Schwerpunktmotu „Quantitative Methoden Schwerpunkt Translationale Biologie“  

**Lehrsprache:** Deutsch  

**Gruppengröße:** 20  

**Moduldauer:** 1 Semester, Block  

**Fachsemester:** 2  

**Angebots-häufigkeit:** Nur im Sommersemester  

**SWS** | Präsenzstudium | Selbststudium | Workload Summe  
--- | --- | --- | ---  
2 | 30 h | 30 h | 60 h  

**Inhalte**  
Quantitative Beschreibung biologischer Systeme  
- Erlernen von Python zur Erstellung einfacher Programme / Skripte  
- Beschreibung genetischer Systeme mit ODEs und deren numerische Lösung mit Python  
- Quantitative Proteomikstrategien zur Untersuchung von cellulären Signalprozessen, Krankheitsursachen und Wirkstoffen  
- Analyse von posttranslationalen Proteinmodifikationen und Protein-Protein-Interaktionen  
Funktionelle Morphologie, Biomechanik und Bionik:  
- Mechanische Beanspruchung von Bäumen (Zug, Druck, Biegung, Eulerisches Knicken)  
- Wichtige Materialkenngrößen bei Pflanzen (Flächenträgheitsmomente, kritische Spannungen, Biegesteifigkeit, Elastizitätsmodul)  
- Grundlagen der Hydrodynamik, Evolution der Wasserleitung bei Pflanzen, Physik Wasserferntransport  
- Korrelation der mechanischen Beanspruchungen und der Wasserleitung mit der Evolution von Stelentypen und Achsenanatomie  
- Bionische Materialien und Oberflächen  

**Lehrmethoden und Medien**  
Frontalvortrag  
Powerpoint / Folienhandout wird verteilt.  

**Lernziele / Lernergebnisse**  
Die Studierenden können  
- die Dynamik in einfachen genetische Netzwerke mit Differentialgleichungen beschreiben  
- verschiedene Formen der mechanischen Beanspruchung von Bäumen beschreiben und können die Evolution der Pflanzen auf diesem Hintergrund diskutieren  
- die wichtigsten Materialkenngrößen bei Pflanzen (Flächenträgheitsmomente, kritische Spannungen, Biegesteifigkeit, Elastizitätsmodul) erläutern  
- die Grundlagen der Hydrodynamik in Bezug auf die Evolution der Wasserleitung bei Pflanzen darlegen  
- die Vor- und Nachteile von Methoden zur quantitativen Proteomanalyse erläutern und sind in der Lage, grafische Darstellungen von Ergebnissen zu verstehen und zu beurteilen.  

**Studienleistung**  
Regelmäßige Teilnahme, 1 Fehltag möglich  

**Prüfungsleistung & Benotung**  
Die Inhalte der Vorlesung sind Bestandteil der mündlichen Prüfung nach Ende des Moduls (75% der Modulnote)  

**Literatur**  
Wird zu Beginn des Moduls zur Verfügung gestellt
Veranstaltungstitel: Quantitative Methoden Schwerpunkt Translationale Biologie
Lehrform: Übung
Modul: Schwerpunktmodul „Quantitative Methoden Schwerpunkt Translationale Biologie“ SP1-01
Verwendbarkeit: Schwerpunktmodul „Quantitative Methoden Schwerpunkt Translationale Biologie“
Lehrsprache: Deutsch
Gruppengröße: 20
Moduldauer: 1 Semester, Block
Fachsemester: 2
Angebots-häufigkeit: Nur im Sommersemester
SWS
<table>
<thead>
<tr>
<th>Präsenzstudium</th>
<th>Selbststudium</th>
<th>Workload Summe</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>75 h</td>
<td>135 h</td>
</tr>
</tbody>
</table>

Inhalte
- Erlernen und Anwenden von „Python“ zur quantitativen Beschreibung biologischer Systeme:
  - Lösen von Differentialgleichungen mit „Python“
  - Numerische Simulation des Verhaltens von genetischen Netzwerken
  - Herleitung und Berechnungen der wichtigsten Kenngrößen zur Charakterisierung der mechanischen Eigenschaften von Pflanzen und des Wasserferntransportes bei Pflanzen (Flächenträgheitsmomente, Eulersches Knicken, Biegeeigenschaften, kritische Spannungen, kapillare Steighöhen, Reynoldszahlen)
  - Verarbeitung, Analyse und grafische Darstellung von Datenreihen aus Experimenten der quantitativen Proteomik.

Lehrmethoden
- Einzelarbeit am Computer
- Debatte über optimale Lösungsstrategien

Lernziele / Lernergebnisse
- Die Studierenden können
  - in Python einfache Programme erstellen zur numerischen Lösung von Differentialgleichungen
  - zur automatisierten Analyse von DNA- und Proteinsequenzen
  - Analyse und grafischen Darstellung von experimentellen Daten
  - die Dynamik in einfachen genetischen Netzwerken mit Differentialgleichungen beschreiben und numerisch simulieren
  - Datenreihen aus quantitativen Proteomanalysen grafisch darzustellen und daraus Schlussfolgerungen zum Verständnis von zellulären Signalprozessen und Protein-Protein-Interaktionen zu ziehen
  - die wichtigsten Kenngrößen zur Charakterisierung der mechanischen Eigenschaften und des Wasserferntransportes von Pflanzen herleiten und für konkrete Beispiele berechnen (Flächenträgheitsmomente, Eulersches Knicken, Biegeeigenschaften, kritische Spannungen, kapillare Steighöhen, Reynoldszahlen)

Studienleistung
- Erfolgreiche (>50% der Punkte) Bearbeitung der Hausaufgaben

Prüfungsleistung & Benotung
- Hausaufgaben fließen zu 25% in die Modulnote ein

Literatur
- Wird zu Beginn des Moduls zur Verfügung gestellt
<table>
<thead>
<tr>
<th>Veranstaltungstitel:</th>
<th>Quantitative Methoden Schwerpunkt Translationale Biologie</th>
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</thead>
<tbody>
<tr>
<td>Lehrform:</td>
<td>Seminar</td>
</tr>
<tr>
<td>Modul:</td>
<td>Schwerpunktmobil „Quantitative Methoden Schwerpunkt Translationale Biologie“ SP1-01</td>
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<tr>
<td>Verwendbarkeit:</td>
<td>Schwerpunktmobil „Quantitative Methoden Schwerpunkt Translationale Biologie“</td>
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<tr>
<td>Lehrsprache:</td>
<td>deutsch</td>
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<td>Gruppengröße:</td>
<td>20</td>
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<tr>
<td>Modulsdauer:</td>
<td>1 Semester, Block</td>
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<td>Fachsemester:</td>
<td>2</td>
</tr>
<tr>
<td>Angebots-häufigkeit:</td>
<td>Nur im Sommersemester</td>
</tr>
<tr>
<td>SWS Präsenzstudium</td>
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</tr>
<tr>
<td>Selbststudium</td>
<td>30 h</td>
</tr>
<tr>
<td>Workload Summe</td>
<td>60 h</td>
</tr>
<tr>
<td></td>
<td>90 h</td>
</tr>
</tbody>
</table>

**Inhalte**
Basierend auf aktueller Literatur sollen folgende Themen im Rahmen von Seminarvorträgen behandelt werden:
- DNA und Proteinsequenzanalyse
- Synthetische genetische Netzwerke
- Funktionelle Proteomik und Protein-Protein-Interaktionen
- Bionik und Biomechanik

**Lehrmethoden**
Seminarvortrag der Studierenden
Powerpointpräsentation

**Lernziele / Lernergebnisse**
Die Studierenden können
- eine aktuelle Studie aus dem Bereich Synthetische Biologie / Proteomforschung / Bionik und Biomechanik analysieren und deren Inhalt im Rahmen eines Seminarvortrages wiedergeben.
- die angewandten Methoden und deren Relevanz für die jeweilige Studie erklären.

**Studienleistung**
Vorstellung eines Seminarvortrages

**Prüfungsleistung & Benotung**
Keine

**Literatur**
Wird zu Beginn des Moduls zur Verfügung gestellt
### Module: Genetics & Developmental Biology

<table>
<thead>
<tr>
<th>Responsible person:</th>
<th>Department(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neubüser, Annette</td>
<td>Genetics &amp; Developmental Biology</td>
</tr>
</tbody>
</table>

#### Type:
Elective module

#### Recommended semester:
2

#### Duration:
1 semester, block course

#### ECTS:
12

#### Recurrency frequency:
Each summer semester

#### Workload:
360 h

#### Recommended qualification:

#### Applicability:
M.Sc. Biology, Major Genetics & Developmental Biology  
M.Sc. Biochemistry and Biophysics, as elective module Biology I

#### Teachers:
Baumeister, Ralf / Driever, Wolfgang / Driller, Katrin / Holzschuh, Jochen / Maier, Wolfgang / Neubüser, Annette / Onichtchouk, Darja / Pyrowolakis, Georgios / Qi, Wenjing / Schulze, Ekkehard

### Courses

<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signaling in Development and Disease</td>
<td>Lecture with tutorial</td>
<td>2</td>
<td>2</td>
<td>60 h</td>
</tr>
<tr>
<td>Animal models in the analysis of Development and Disease</td>
<td>Practical exercise</td>
<td>7</td>
<td>7</td>
<td>210 h</td>
</tr>
<tr>
<td>Aberrant signaling in human diseases: From mechanism to therapy</td>
<td>Seminar</td>
<td>3</td>
<td>2</td>
<td>90 h</td>
</tr>
</tbody>
</table>

### Goals

The aims of this module are (1) a molecular-level understanding of the most relevant signaling pathways during embryonic development and of their contributions to human diseases, and (2) knowledge of and practical experiences with experimental approaches using animal models to study signaling processes and developmental mechanisms in vivo.

The students are able to:
- explain common principles and mechanisms of signaling processes in animals
- describe and draw the most important signaling pathways in animal development and human diseases with examples.
- describe basic research concepts to address signaling processes using multi-cellular animal organisms.
- conduct state-of-the-art experiments for studying research problems of signaling research and developmental biology.
- document and discuss results from own scientific experiments.
- search scientific literature in databases and to present and discuss current research topics in English
- write a mini-review type of paper on a given topic in English

### Achievements

- Active participation in lectures, tutorials, seminars and practical courses
- Preparation of two course protocols
- Preparation of a seminar presentation
- Preparation of a paper in the format of a mini-review in English on the topic of the seminar presentation
- Two short oral examinations (1/3)
- Activity and presentation within the seminars, quality of the written paper (1/3)
- Written protocols of lab exercises (1/3)

### Exams

- Alberts: Molecular Biology of the Cell
- Gomberts: Signal Transduction (2nd Ed)
- S.F.Gilbert: Developmental Biology (10th Ed)
<table>
<thead>
<tr>
<th>Course:</th>
<th>Signaling in Development and Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Lecture with tutorials</td>
</tr>
<tr>
<td>Module:</td>
<td>Schwerpunktsmodul: Genetics &amp; Developmental Biology SP1-02</td>
</tr>
<tr>
<td>Applicability:</td>
<td>Schwerpunktsmodul: Genetics &amp; Developmental Biology M.Sc. Biochemistry and Biophysics, as elective module Biology I</td>
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<tr>
<td>Language:</td>
<td>English</td>
</tr>
<tr>
<td>Number of participants:</td>
<td>16</td>
</tr>
<tr>
<td>Duration:</td>
<td>1 semester, block course</td>
</tr>
<tr>
<td>Recommended semester:</td>
<td>2</td>
</tr>
<tr>
<td>Recurrency frequency:</td>
<td>only in summer semester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 h</td>
<td>30 h</td>
<td>60 h</td>
</tr>
</tbody>
</table>

Contents

The lecture series covers concepts and mechanisms of signaling processes in multi-cellular organisms at an advanced level. The essential signaling cascades in animal organisms are presented in detail using examples from development; their implications for human diseases are discussed.

Specifically the lectures address:
- Signaling mechanisms: signal generation & modulation, receptors, signal transduction, kinase cascades, nuclear readouts, signal integration, gradients, quantitative aspects of signaling
- Essential signaling cascades in higher eukaryotes: WNT, TGFbeta, FGF, SHH, Retinoic Acid, Delta/Notch, IGF, cell adhesion based signaling - mechanisms and molecules
- Examples of signaling processes in early development and during organogenesis
- Human genetic diseases and cancer caused by altered signaling, and therapeutic approaches

Teaching methods and media

Lectures and tutorials. In each lecture a list of questions/problem will be distributed for the students to work on. These will then be discussed in tutorials.
Media: PowerPoint-Presentations, handouts, problem sheets; blackboard; Materials are provided on the ILIAS platform.

Goals

The students are able to
- describe and draw the most important signaling pathways in animal development, and explain their relevance using examples from development.
- explain the relevance of key signaling pathways for human diseases, and suggest rational therapeutic strategies.

Achievements

Active participation in lectures and tutorials

Exams

Two short oral examinations covering the content of the lecture series (and the practical exercise and seminar) together make $\frac{1}{3}$ of the module grade

Literature

- Alberts: Molecular Biology of the Cell
- Gomberts: Signal Transduction (2nd Ed)
- Gilbert: Developmental Biology (10th ed)
- Primary and Review articles specified in the lectures
<table>
<thead>
<tr>
<th>Course:</th>
<th>Animal models in the analysis of Development and Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Practical exercise</td>
</tr>
<tr>
<td>Module:</td>
<td>Schwerpunktmodulmodul I „Genetics &amp; Developmental Biology“</td>
</tr>
<tr>
<td></td>
<td>SP1-02</td>
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<tr>
<td>Applicability:</td>
<td>Schwerpunktmodulmodul I „Genetics &amp; Developmental Biology“</td>
</tr>
<tr>
<td></td>
<td>M.Sc. Biochemistry and Biophysics, as elective module Biology I</td>
</tr>
<tr>
<td>Language:</td>
<td>English</td>
</tr>
<tr>
<td>Number of participants:</td>
<td>16</td>
</tr>
<tr>
<td>Duration:</td>
<td>1 semester, block course</td>
</tr>
<tr>
<td>Recommended semester:</td>
<td>2</td>
</tr>
<tr>
<td>Recurrency frequency:</td>
<td>only in summer semester</td>
</tr>
<tr>
<td>SWS</td>
<td>Workload contact time</td>
</tr>
<tr>
<td>7</td>
<td>110 h</td>
</tr>
</tbody>
</table>

### Contents

The exercises will enable the participants to design and perform complex experiments with a focus on how to use animal model organisms to analyze signaling mechanisms during development and disease. They will gain experience with working with several model organisms and learn a wide array of up-to-date technologies including:

- handling of adults and isolation of *Drosophila* and *C. elegans* embryos
- isolation and handling and manipulation of mouse, chick and zebrafish embryos
- experimental design using model organisms and their mutants
- identification, genotyping and analysis of transgenic embryos
- application of reporter gene assays
- signaling pathway manipulations in vivo
- life imaging & microscopic analysis
- behavioral biology
- *in situ* approaches
- phenotypic consequences of loss- and gain-of function studies and their mechanistic interpretations
- embryo microinjections
- organ culture techniques
- microsurgery on living embryos
- cross-species interpretation of experimental results
- use of model organisms to understand (and help curing) human diseases

### Teaching methods and media

- Introductory presentations (powerpoint),
- Discussion of the experiments in the plenum
- Practical demonstration of key techniques by the teaching staff
- Experimental work by the students (performed individually or in small teams)
- Discussion of the results with peers and teaching staff
- Presentation of the results and their scientific context by the students
- Written scientific protocols of experimental work and feedback on the protocol by the teaching staff

### Goals

The students are able to

- plan, design, perform and document experiments on a current research topic in the field of developmental biology using animal model organisms
- present, evaluate and discuss results from own experimental studies and integrate them into the state of the art of the research field

### Achievements

- Active participation in experimental courses
- Preparation of two course protocols

### Exams

Written scientific protocols of experimental work together make 1/3 of the module grade
<table>
<thead>
<tr>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Specific scripts for the experimental work</td>
</tr>
<tr>
<td>• S.F. Gilbert: Developmental Biology (10th Ed)</td>
</tr>
<tr>
<td>• Wolpert and Tickle: Principles of Development (4th Ed)</td>
</tr>
<tr>
<td>• Alberts: Molecular Biology of the Cell</td>
</tr>
<tr>
<td>• Gomberts: Signal Transduction (2nd Ed)</td>
</tr>
<tr>
<td>• Selected literature of the individual research topic (original articles, reviews)</td>
</tr>
<tr>
<td>Course:</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Type:</td>
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<table>
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<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total Workload</th>
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<tbody>
<tr>
<td>2</td>
<td>20 h</td>
<td>70 h</td>
<td>90 h</td>
</tr>
</tbody>
</table>

**Contents**

The seminar will focus on the relevance of signaling pathways for human diseases and will cover molecular mechanisms, experimental approaches used for analysis, and therapeutic strategies. The students will present a seminar talk on a current scientific topic related to signaling mechanisms in human diseases, and will write a short paper on this topic in the format of mini-review.

**Teaching methods and media**

- Independent capturing of the content of the original literature received.
- Identification of additional scientific literature relevant for the topic.
- Identification of weak or possibly critical points in the articles;
- Individual discussion of scientific content with the respective lecturer;
- Preparation of seminar presentation and of a hand-out;
- Presentation of the seminar (using power point or suitable open-source based software);
- Discussion of presentation content with all other participants of the seminar;
- Preparation of a mini-review on the topic in English;
- Feedback on the mini-review and suggestions for improvement by the teaching staff.

**Goals**

- The students are able to
  - search literature relevant for a given scientific problem in databases and libraries
  - extract and summarize the current knowledge on a scientific topic from the literature
  - present and discuss research results from publications
  - plan and design a scientific talk in form of a power point presentation in English
  - write a mini-review type of paper on a given topic in English

**Achievements**

- Attendance of seminar talks
- Active participation in seminars
- Preparation of a seminar presentation and own seminar talk
- Preparation of a written paper in the format of a mini-review

**Exams**

Activity and presentation within the seminars, quality of the written paper (1/3)

**Literature**

Selected original research publications are provided.
### Module: Biology I - Microbiology and Systems Biochemistry

<table>
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<tr>
<th>Schwerpunktmodul I (M.Sc.)</th>
<th>SP1-04</th>
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<th>Department(s):</th>
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<tr>
<td>Boll, Matthias</td>
<td>Microbiology Department of Biology</td>
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</tbody>
</table>

**Type:** Elective module  
**Recommended semester:** 2  
**Duration:** 1 semester, block course  
**ECTS:** 12  
**Recurrency frequency:** every summer semester  
**Workload:** 360 h

**Recommended qualification:**
M.Sc. Biology, Major Biochemistry & Microbiology  
M.Sc. Biochemistry and Biophysics, as elective module Biology I

**Applicability:**
M.Sc. Biology, Major Biochemistry & Microbiology  
M.Sc. Biochemistry and Biophysics, as elective module Biology I

**Teachers:**
Berg, Ivan / Boll, Matthias / Drepper, Friedel / Kung, Johannes / Oeljeklaus, Silke / Radziwill, Gerald / Suppanz, Ida / Warscheid, Bettina

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
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</thead>
<tbody>
<tr>
<td>Microbial Biochemistry</td>
<td>Lecture</td>
<td>2</td>
<td>2</td>
<td>60 h</td>
</tr>
<tr>
<td>Methods in Microbial Biochemistry</td>
<td>Exercise</td>
<td>7</td>
<td>5</td>
<td>210 h</td>
</tr>
<tr>
<td>Current applied aspects of microbial biochemistry</td>
<td>Seminar</td>
<td>3</td>
<td>2</td>
<td>90 h</td>
</tr>
</tbody>
</table>

**Goals**
- The students are able to describe and draw the most important types of microbial metabolism, they can describe the function of key enzymes involved in metabolic pathways of microorganisms.
- The students are able to conduct experiments for studying metabolic pathways and central cellular functions such as protein transport.
- The students are able to enrich bacteria with special metabolic capacities from nature.
- The students are able to document and discuss results from own scientific experiments.
- The students are able to search scientific literature in databases and to present and discuss current research topics of microbiology and biochemistry.

**Achievements**
- Regular participation at the lectures and practical course (at least 90%)
- protocols for experiments during the practical course
- preparation and presentation of a scientific seminar talk

**Exams**
- Oral examination (30 min) about the contents of the lecture and the practical course

**Literature**
- Fuchs, Allgemeine Mikrobiologie, Thieme
- Brock, Mikrobiologie, Pearson
- Selected journal reviews and articles
Course: Microbial Biochemistry

Type: Lecture

Module: Schwerpunktmodul I "Microbiology and Systems Biochemistry"

Applicability: Schwerpunktmodul I "Microbiology and Systems Biochemistry" M.Sc. Biochemistry and Biophysics, as elective module Biology I

Language: German/English

Number of participants: 24

Recommended semester: 2

Recurrency frequency: every summer semester

<table>
<thead>
<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 h</td>
<td>30 h</td>
<td>60 h</td>
</tr>
</tbody>
</table>

Contents

The lecture aims to impart knowledge of microbial biochemistry with a focus on microbial metabolism and cellular function of eukaryotic microorganisms. Applied aspects comprise global element cycles, biotechnology and ecology.

Main topics:
- Catabolism of various carbon substrates in aerobic/anaerobic microorganisms
- Fermentations and anaerobic respiratory chains in bacteria and archaea
- Chemolithotrophy
- Bacterial photosynthesis
- C-/N- ans S-assimilation in microorganisms
- Bacterial photosynthesis
- Extremophilic microorganisms
- Organellar biochemistry from yeast to human
- Diseases associated with organellar dysfunctions
- Quantitative and functional yeast proteomics

Teaching methods and media

Lecture, Blackboard, Video, Power-Point-presentation

Goals

- The students are able to describe and draw the most important types of microbial metabolism, they can describe the function of key enzymes involved in metabolic pathways of microorganisms
- The students are able to describe applied biotechnological and ecological aspects of microbial metabolism
- The students are able to recap processes involved in the biosynthesis and (mal)functions of metabolic cell organelles
- The students are able to recap strategies for the functional analysis of proteins by biochemical and quantitative proteomics methods

Achievements

Regular attendance (at least 90%)

Exams

Oral examination (30 min) about the contents of the lecture

Literature

- Fuchs, Allgemeine Mikrobiologie
- Selected journal reviews and articles
Course: Methods in Microbial Biochemistry

Type: Exercise

Module: Schwerpunktmödul I "Microbiology and Systems Biochemistry" SP1-04

Applicability: Schwerpunktmödul I "Microbiology and Systems Biochemistry" M.Sc. Biochemistry and Biophysics, as elective module Biology I

Language: German or English

Number of participants: 24

Duration: 1 semester, block course

Recommended semester: 2

Recurrency frequency: every summer semester

<table>
<thead>
<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total workload</th>
</tr>
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<tbody>
<tr>
<td>5 h</td>
<td>75 h</td>
<td>135 h</td>
<td>210 h</td>
</tr>
</tbody>
</table>

Contents

The practical course imparts general knowledge of methods in microbial metabolism and microbial cellular functions.

The methods of the lab course comprise:

- Cultivation of bacteria up to the 200-L-scale
- Characterization of microbial metabolic pathways by detection of key enzymes on the gene (PCR), protein (mass spectrometry) and activity (spectrophotometric assays, HPLC analyses) level
- Enrichment of bacteria with special metabolic capacities from nature (enrichment culture may be further investigated in other courses in microbiology)
- Metabolic labeling of yeast cells (SILAC)
- Isolation of yeast organelles (differential centrifugation)
- Analysis of auxotrophic and knock-out yeast strains
- Global quantitative proteomics (UHPLC/high resolution MS/MS), bioinformatics data analysis and visualization
- In vivo protein localization by fluorescence microscopy

Teaching methods and media

Team work in the laboratory, protocol, presentation of own experimental data

Goals

- The students are able to conduct experiments for studying microbial metabolic pathways and central cellular functions (e.g. protein transport)
- The students are able to study organelles and proteins with essential cellular functions using the eukaryotic model organism yeast
- The students are able to analyze and visualize large quantitative proteomics datasets
- The students are able to document and discuss results from own scientific experiments

Achievements

Regular participation (at least 90%), protocol

Exams

Oral examination (30 min) about the contents of the practical course

Literature

Scriptum provided
<table>
<thead>
<tr>
<th><strong>Course:</strong></th>
<th>Current applied aspects of microbial biochemistry</th>
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</thead>
<tbody>
<tr>
<td><strong>Type:</strong></td>
<td>Seminar</td>
</tr>
<tr>
<td><strong>Module:</strong></td>
<td>Schwerpunktmodul I &quot;Microbiology and Systems Biochemistry&quot; SP1-04</td>
</tr>
<tr>
<td><strong>Applicability:</strong></td>
<td>Schwerpunktmodul I &quot;Microbiology and Systems Biochemistry&quot; M.Sc. Biochemistry and Biophysics, as elective module Biology I</td>
</tr>
<tr>
<td><strong>Language:</strong></td>
<td>English</td>
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<td><strong>Number of participants:</strong></td>
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<tr>
<td><strong>Duration:</strong></td>
<td>1 semester, block course</td>
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<td><strong>Recommended semester:</strong></td>
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<tr>
<td><strong>Recurrency frequency:</strong></td>
<td>every summer semester</td>
</tr>
<tr>
<td><strong>SWS</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Workload contact time</strong></td>
<td>30 h</td>
</tr>
<tr>
<td><strong>Workload self-study</strong></td>
<td>60 h</td>
</tr>
<tr>
<td><strong>Total workload</strong></td>
<td>90 h</td>
</tr>
</tbody>
</table>

**Contents**

The seminar imparts knowledge of special aspects of current applied research topics of microbial biochemistry. Main Topics are:

- Synthesis/degradation of bioplastics
- Degradation of pollutants, bioremediation
- Bioenergy, microbial fuel cells
- Global elemental cycle
- Novel aspects of energy conservation in microorganism
- Novel metabolic pathways
- Symbioses
- Metabolism and virulence
- New aspects in organellar biochemistry
- Protein import & signaling processes in yeast
- The quantitative proteomics toolbox applied to yeast

**Teaching methods and media**

Single Power-Point-presentation, handout

**Goals**

- The students are able to search scientific literature in databases.
- The students are able to present and discuss current research topics of microbiology and biochemistry

**Achievements**

- Regular participation (at least 90%)
- Preparation and presentation of a seminar talk

**Exams**

None

**Literature**

Selected scientific literature
### Module
**Biology I - „Advanced Biochemistry and Biophysics of Proteins“**

**Department**  
Biochemistry (chemical department)

**Recommended semester:** 2. FS

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>Workload</th>
<th>P/W</th>
<th>SWS</th>
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</thead>
<tbody>
<tr>
<td>„Advanced Biochemistry and Biophysics of Proteins“</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Responsible person**  
Prof. T. Friedrich

**Teachers**  
Andrade, Einsle, Friedrich, Gerhardt, Wohlwend

**Recurrency frequency**

**Language**  
German/English

**Requirements**  
The module “Biochemistry Lab Course” has to be passed before

**Goals**

**Contents**
- Membrane protein preparation (Methods)
- Electrophysiology (Liposome techniques, SSM-techniques)
- Anoxic protein biochemistry
- Analytical Methods: SEC/RALS; ITC
- Crystallography: Data processing, structure solution, refinement, visualization
- Protein Spectroscopy: UV/vis, steady-state/transient/fast kinetics
- EPR: Theory, practice and simulation

**Achievements and Exams**  
PL

**Literature**
## Module Biology II

**Department:** Biology  
**Recommended semester:** 2. FS  
**ECTS CP:** 9

<table>
<thead>
<tr>
<th>Modules</th>
<th>Type</th>
<th>Workload</th>
<th>Workload</th>
<th>P/W</th>
<th>SWS</th>
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</table>
| It is mandatory to choose one of the following elective modules:  
  a. Mammalian and Plant Cell Technology  
  b. Signalling in Tumour Cells – Functional Proteomic Studies  
  c. Molekularbiologie der Prokaryoten  
  d. The cell at high resolution  
  e. Cell-free synthesis of proteins and label-free detection of protein-protein interactions | | | | | |

### Responsible persons

**Teachers**

**Reccurrency frequency**
every SS, 4 weeks block course after the Whitsun break („Pfingstpause“)

**Language**
German/English

**Requirements**
The module “Biochemistry Lab Course” has to be passed before

### Goals

**Contents**
See the individual descriptions of the major modules in biology on the following pages.

**Achievements and Exams**

**Literature**

**Note:** The modules described on the following pages are elective modules (“Wahlmodule”) for students in the M.Sc. program in biology, this is why the corresponding terms and abbreviations (WM) are used in this module guide as well as in the course catalog. For students in the Biochemistry and Biophysics program, they are elective modules that may be chosen as module “Biology II”.

---

M.Sc. Biochemistry and Biophysics  
Effective January 2017
## Module: Biology II - Mammalian and Plant Cell Technology

<table>
<thead>
<tr>
<th>Responsible person:</th>
<th>Department(s):</th>
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</thead>
<tbody>
<tr>
<td>Zurbrigg, Matias</td>
<td>Biochemistry (Synthetic Biology)</td>
</tr>
</tbody>
</table>

### Type:
- Elective module

### Recommended semester:
- 3

### Duration:
- 1 semester, block course

### ECTS:
- 9

### Recurrency frequency:
- Summer semester

### Workload:
- 270 h

### Recommended qualification:

### Applicability:
- M.Sc. Biochemistry and Biophysics: as elective module Biology II

### Teachers:
- Decker, Eva / Radziwill, Gerald / Reski, Ralf / Sprossmann, Natasha / Weber, Wilfried / Zurbrigg, Matias

<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tbody>
<tr>
<td>Products from cells, cells as products</td>
<td>Lecture</td>
<td>2</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>Mammalian and Plant Cell Technology</td>
<td>Practical exercise</td>
<td>4</td>
<td>3.5</td>
<td>120</td>
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<tr>
<td>Current Trends in Cell Technology and Synthetic Biology</td>
<td>Seminar</td>
<td>3</td>
<td>2</td>
<td>90</td>
</tr>
</tbody>
</table>

### Goals
- The students are able to
  - describe the principles of mammalian and plant cell culture technologies
  - describe the principles of synthetic biology
  - handle mammalian and plant cells.
  - manage different DNA transfer methods
  - apply high-end molecular biology tools
  - develop, implement and analyse synthetic gene networks.
  - produce and purify recombinant proteins
  - prepare and utilise smart biohybrid materials
  - analyse the connections between basic research results and their implementation into marketable products

### Achievements
- At least 90% attendance, active participation.
- Presentation in the seminar.
- Writing of experimental lab journal.

### Exams
- None

### Literature
- A course script, scientific original and review articles will be distributed and could be complemented by the students’ own interests
### Course: Products from cells, cells as products

<table>
<thead>
<tr>
<th><strong>Type:</strong></th>
<th>Lecture</th>
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<tbody>
<tr>
<td><strong>Module:</strong></td>
<td>Wahlmodul “Mammalian and Plant Cell Technology” WM-09</td>
</tr>
<tr>
<td><strong>Applicability:</strong></td>
<td>Wahlmodul “Mammalian and Plant Cell Technology” M.Sc. Biochemistry and Biophysics: as elective module Biology II</td>
</tr>
<tr>
<td><strong>Language:</strong></td>
<td>English</td>
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<tr>
<td><strong>Number of participants:</strong></td>
<td>20</td>
</tr>
<tr>
<td><strong>Duration:</strong></td>
<td>1 semester, block course</td>
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<tr>
<td><strong>Recommended Semester:</strong></td>
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<tr>
<td><strong>Recurrency frequency:</strong></td>
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#### SWS

<table>
<thead>
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<th><strong>Workload contact time</strong></th>
<th><strong>Workload self-study</strong></th>
<th><strong>Total workload</strong></th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>30 h</td>
<td>60 h</td>
</tr>
</tbody>
</table>

### Contents

The lecture gives a comprehensive overview of mammalian and plant cell technology and synthetic biology. The following areas will be covered:

- Mammalian and plant cell culture: handling, cultivating and propagating animal and plant cells.
- DNA transfer in cell culture and gene therapy.
- Synthetic biological switches and sensors to control and analyze cell fate and function.
- Design of synthetic gene networks for programming cells.
- Biomedical applications of synthetic biology.
- Synthetic biology in materials sciences.
- Scale-up: from bench to bioreactor.
- Founding a biotech start-up company.

### Teaching methods and media

Frontal lectures presented by lecturers from different fields, Power Point presentations, Printed handouts

### Goals

The students are able to

- describe the principles of mammalian and plant cell culture technologies
- describe the principles of synthetic biology
- analyse the connections between basic research results and their implementation into marketable products

### Achievements

At least 90% attendance, active participation.

### Exams

None

### Literature

Scientific original and review articles (will be distributed).
Course: Mammalian and Plant Cell Technology

Type: Practical exercise

Module: Wahlmodul "Mammalian and Plant Cell Technology" WM-09

Applicability: Wahlmodul "Mammalian and Plant Cell Technology"
M.Sc. Biochemistry and Biophysics: as elective module Biology II

Language: English

Number of participants: 20

Duration: 1 semester, block course

Recommended semester: 2

Recurrency frequency: Only in summer semester

<table>
<thead>
<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total workload</th>
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</thead>
<tbody>
<tr>
<td>3,5</td>
<td>52,5 h</td>
<td>67,5 h</td>
<td>120 h</td>
</tr>
</tbody>
</table>

Contents
In this course comprehensive practical experience will be gained in mammalian and plant cell technology:
- Observation and cultivation of mammalian and plant cells.
- Transfection of mammalian and plant cells
- Retroviral transduction and viral tropism.
- Design and implementation of synthetic gene networks
- Analysis of gene expression by enzymatic assays, fluorescence microscopy and immunological methods.
- Bioreactor operation for cells, moss and more.
- Purification and characterization of recombinant proteins.
- Cell encapsulation for cell therapy.
- Biohybrid materials as smart drug depots.

Teaching methods and media
The experimental part will be carried out in groups of 3 students. Each student prepares a lab journal.

Goals
The students are able to
- handle mammalian and plant cells.
- manage different DNA transfer methods
- apply high-end molecular biology tools
- develop, implement and analyse synthetic gene networks and optogenetic devices.
- produce and purify recombinant proteins
- prepare and utilise smart biohybrid materials

Achievements
- At least 90% attendance, active participation.
- Prior to each experimental session, the students have to make a colloquium (methodological aspects and organisatorial issues will be discussed).
- The students will write a lab journal at the end of the practical part.

Exams
None

Literature
A complete script of the experimental part will be distributed
<table>
<thead>
<tr>
<th>Course:</th>
<th>Current Trends in Cell Technology and Synthetic Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Seminar</td>
</tr>
<tr>
<td>Module:</td>
<td>Wahlmodul &quot;Mammalian and Plant Cell Technology&quot; WM-09</td>
</tr>
<tr>
<td>Language:</td>
<td>English Number of participants: 20</td>
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<tr>
<td>Duration:</td>
<td>1 semester, block course Recommended semester: 2</td>
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<tr>
<td>Recurrency frequency:</td>
<td>Only in summer semester</td>
</tr>
<tr>
<td>SWS</td>
<td>Workload contact-time</td>
</tr>
<tr>
<td>2</td>
<td>30 h</td>
</tr>
</tbody>
</table>

Contents
Insight into current trends of cell technology, synthetic biology and recombinant protein production.

Teaching methods and media
- The students, in groups of 4, are supplied with a list of actual topics and experimental developments (or are able to search for a case) in the field of synthetic biology that could lead to a marketable product.
- Each group should search for literature, analyse the case and prepare and present a seminar consisting of:
  - project for the funding of a biotechnological start-up company capitalising on the chosen development
  - market analysis
  - scheme of business plan.
- Supervision by a lecturer

Goals
The students are able to
- perform literature research on current synthetic biology advances
- analyse the data and prepare and present the results
- discuss the presented work with their fellows and lecturers.
- analyse the connections between basic research results and their implementation into marketable products

Achievements
- perform literature research
- analyse the connection between basic research results and their implementation into marketable products
- develop a scheme of a business plan
- power point presentation of the seminar, preparation of a website
- Attendance 90%

Exams
None

Literature
Original and review scientific articles
<table>
<thead>
<tr>
<th>Module:</th>
<th>Biology II - Signalling in Tumor Cells – Functional Proteomic Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wahlmodul (M.Sc.)</td>
<td>WM-17</td>
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<tr>
<td>Responsible person:</td>
<td>Department(s):</td>
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<tr>
<td>Radziwill, Gerald</td>
<td>Biochemistry, biology department</td>
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<td>Type:</td>
<td>Recommended semester:</td>
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<td>Duration:</td>
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<td>Recommended qualification:</td>
<td>Requirements:</td>
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<td>Applicability:</td>
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<td>M.Sc. Biology: elective module A in the Majors Translational Biology and Biochemistry &amp; Microbiology</td>
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<td>M.Sc. Biochemistry and Biophysics: as elective module Biology II</td>
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<td>Teachers:</td>
<td></td>
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<tr>
<td>Drepper, Friedel / Oeljeklaus, Silke / Radziwill, Gerald / Warscheid, Bettina / Wiese, Heike</td>
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<tr>
<td>Courses</td>
<td>Type</td>
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<tr>
<td>Signalling in Normal and Tumour Cells – Analysis by Functional Proteomic Approaches</td>
<td>Lecture</td>
</tr>
<tr>
<td>Cell Culture Technology &amp; Phosphoproteomics</td>
<td>Practical exercise</td>
</tr>
<tr>
<td>Latest Trends &amp; Technologies in Signaling and Functional Proteomics</td>
<td>Seminar</td>
</tr>
<tr>
<td>Goals</td>
<td>The students are able to</td>
</tr>
<tr>
<td>• explain fundamental features of signaling in health and disease.</td>
<td></td>
</tr>
<tr>
<td>• describe proteomic-based approaches used to analyze signaling events.</td>
<td></td>
</tr>
<tr>
<td>• design and perform experiments to analyze signaling pathways in mammalian cells.</td>
<td></td>
</tr>
<tr>
<td>• identify phosphopeptides in a data set generated by mass spectrometry.</td>
<td></td>
</tr>
<tr>
<td>• document, analyze and present their experimental data.</td>
<td></td>
</tr>
<tr>
<td>• elaborate a scientific topic based on literature search.</td>
<td></td>
</tr>
<tr>
<td>Achievements</td>
<td></td>
</tr>
<tr>
<td>• Active participation</td>
<td></td>
</tr>
<tr>
<td>• Record experimental conditions and results in a lab journal</td>
<td></td>
</tr>
<tr>
<td>• Attendance 90% (one absent day maximal)</td>
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<tr>
<td>Exams</td>
<td>None</td>
</tr>
<tr>
<td>Literature</td>
<td></td>
</tr>
<tr>
<td>• Lottspeich, Engels, Simeon (2012): „Bioanalytik”, 3. Auflage, Spektrum Akademischer Verlag; Heidelberg; Chapter 16</td>
<td></td>
</tr>
<tr>
<td>• Selected review articles (will be distributed)</td>
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<tr>
<td>• Script (will be distributed)</td>
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<tr>
<td>Course:</td>
<td>Signaling in Normal and Tumor Cells – Analysis by Functional Proteomic Approaches</td>
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<tr>
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<tr>
<td>Type:</td>
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<tr>
<td>Module:</td>
<td>Wahlmodul “Signaling in Tumor Cells – Functional Proteomic Studies” WM-17</td>
</tr>
<tr>
<td>Language:</td>
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<tr>
<td>Number of participants:</td>
<td>15</td>
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<td>Duration:</td>
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<td>Recurrency frequency:</td>
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<tr>
<td>SWS</td>
<td>Workload contact time Workload self-study Total workload</td>
</tr>
<tr>
<td>2</td>
<td>24 h 36 h 60 h</td>
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</table>

**Contents**

The lecture will provide a comprehensive overview of signalling pathways in health and disease and functional proteomics strategies combined with bioinformatics approaches:
- Protein kinases and phosphatases in signalling networks
- Oncogenes and tumour suppressors
- Signalling in health and disease
- Protein kinases as targets in tumour therapy
- Advanced technologies to study posttranslational protein modifications
- Phosphoproteomics
- Quantitative proteomics (SILAC)
- High resolution mass spectrometry
- Bioinformatics tools

**Teaching methods and media**

- Lectures by different lecturers
- PowerPoint presentation
- Handouts

**Goals**

The students are able to:
- Describe mechanistic and functional aspects of protein kinases and phosphatases
- Emphasize differences in signaling in health and disease
- Define the mechanism of action of drugs used in tumor therapy
- Explain state of the art technologies used to study posttranslational modifications
- Explain the principles of high resolution mass spectrometry
- Apply bioinformatics tools

**Achievements**

- Active participation
- Attendance 90% (one absent day maximal)

**Exams**

None

**Literature**

- Lottspeich, Engels, Simeon (2012): „Bioanalytik“, 3. Auflage, Spektrum Akademischer Verlag; Heidelberg; Chapter 16
- Selected review articles (will be distributed)
Course: Cell Culture Technology & Phosphoproteomics

Type: Practical exercise

Module: Wahlmodul “Signaling in Tumor Cells – Functional Proteomic Studies” WM-17


Language: German/English

Number of participants: 15

Duration: 1 semester, block course

Recommended semester: 2

Recurrency frequency: Only in summer semester

<table>
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<tbody>
<tr>
<td>3</td>
<td>45 h</td>
<td>60 h</td>
<td>105</td>
</tr>
</tbody>
</table>

Contents

- Students will gain broad practical knowledge in cell culture technology and functional proteomics methods to analyse signalling mechanisms
  - Handling and cultivation of mammalian cells
  - Transfection of mammalian cells
  - Fluorescence Microscopy
  - Expression and analysis of protein kinases
  - Inhibition of signalling pathways in breast cancer cells
  - Purification and detection of phosphoproteins
  - MS-based analysis of phosphoproteins
  - Protein-protein interactions: affinity chromatography-MS
  - Bioinformatics approaches & data analysis

Teaching methods and media

- Experiments performed in groups of three students
- Supervision by experienced and engaged scientists
- Documentation of experimental conditions and results in a lab journal
- Each group will present their results on the last day by a PowerPoint presentation

Goals

- The students are able to
  - handle and cultivate mammalian cells
  - use DNA transfer methods
  - purify and detect proteins ectopically expressed in mammalian cells
  - analyze the enzyme activity of protein kinases
  - identify phosphorylated peptides by LC-MS/MS
  - interpret their results by bioinformatics tools
  - document experimental data in a lab journal
  - analyze the data and present the data in a short presentation

Achievements

- Active participation
- Record experimental conditions and results in a lab journal
- Presentation of the results
- Attendance 90% (one absent day maximal)

Exams

- None

Literature

- Lottspeich, Engels, Simeon (2012): „Bioanalytik“, 3. Auflage, Spektrum Akademischer Verlag; Heidelberg; Chapter 16
- Selected review articles (will be distributed)
- Script (will be distributed)
<table>
<thead>
<tr>
<th>Course:</th>
<th>Latest Trends &amp; Technologies in Signaling and Functional Proteomics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
<td>Seminar</td>
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<tr>
<td>Module:</td>
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<td>Number of participants:</td>
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<td>Duration:</td>
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<td>SWS</td>
<td>Workload contact time</td>
</tr>
<tr>
<td>2,3</td>
<td>34,5 h</td>
</tr>
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</table>

### Contents
Discussion of latest trends & technologies in signalling and functional proteomics
- Signaling in health and disease
- Oncogenes and tumor suppressors
- Targeting signaling pathway for therapeutic intervention
- MS-based approaches to analyze posttranslational modifications
- Proteomics and disease

### Teaching methods and media
- Each groups of three students will select and work on one of the topics
- Literature search
- Presentation in a seminar
- Supervision by a lecturer

### Goals
The students are able to
- search for relevant literature to a given topic
- conceive central messages of scientific publications
- present and discuss a specific scientific topic

### Achievements
- Literature search and presentation of a seminar
- Active participation
- Attendance 90% (one absent day maximal)

### Exams
None

### Literature
selected by the students
Module: Biology II – Molecular Biology of Prokaryotes

<table>
<thead>
<tr>
<th>Wahlmodul (M.Sc.)</th>
<th>WM-11</th>
</tr>
</thead>
</table>

Responsible person: Wilde, Annegret

Department(s): Genetics, Microbiology

Type: Elective module

Recommended semester: 3

Duration: 1 semester, block course

ECTS: 9

Recommended frequency: Summer semester

Workload: 270 h

Applicability:
M.Sc. Biologie, Wahlmodul A in den Schwerpunkten Biochemie & Mikrobiologie, Genetik & Entwicklungsbiologie, Pflanzenwissenschaften
M.Sc. Biochemistry and Biophysics: as elective module Biology II

Teachers: Hess, Wolfgang / Wilde, Annegret / N.N.

The courses within this module (lecture, exercise and seminar) are taught in German language. Accordingly, the following descriptions are given in German:

<table>
<thead>
<tr>
<th>Veranstaltungstitel</th>
<th>Lehrform</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molekularbiologie der Prokaryoten</td>
<td>Vorlesung</td>
<td>2</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>Vom Signal zum Aufbau von Multiproteinkomplexen</td>
<td>Übung</td>
<td>5</td>
<td>4</td>
<td>150</td>
</tr>
<tr>
<td>Molekulare und biochemische Methoden</td>
<td>Seminar</td>
<td>2</td>
<td>1</td>
<td>60</td>
</tr>
</tbody>
</table>

Lernziele / Lernergebnisse

Die Studierenden:
- kennen die Methoden, mit denen molekulare Prozesse der Signaltransduktion in Bakterien untersucht werden und können diese anwenden
- sind in der Lage aktuelle Publikationen auf dem Gebiet der Molekularbiologie der Prokaryoten zu verstehen und Fragestellungen und Untersuchungsergebnisse sowie die verwendeten Methoden wissenschaftlich korrekt wiederzugeben
- erlangen die Fähigkeit, mit Hilfe der erlernten Methoden und experimentellen Ansätze eigene Erkenntnisse kritisch zu bewerten und Schlussfolgerungen zu ziehen
- können Genregulationsmechanismen in Eubakterien und Archaea auf verschiedenen Ebenen beschreiben und an Beispielen erläutern

Studienleistung

- Regelmäßige Teilnahme, mindestens 80% Anwesenheitszeit, versäumte Versuche müssen nachgeholt werden
- Vorbereiten eines Seminarvortrags
- Mündliche Präsentation eines Seminarthemas
- Protokoll über die durchgeführten Versuche

Prüfungsleistung & Benotung

Keine

Literatur

- Watson, "Molekularbiologie"
- B. Lewin "Genes X"
- Aktuelle wissenschaftliche Veröffentlichungen werden zur Verfügung gestellt.
### Veranstaltungstitel: Molekularbiologie der Prokaryoten

<table>
<thead>
<tr>
<th>Lehrform:</th>
<th>Vorlesung</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modul:</td>
<td>Wahlmodul „Molekularbiologie der Prokaryoten“ WM-11</td>
</tr>
<tr>
<td>Verwendbarkeit:</td>
<td>Wahlmodul „Molekularbiologie der Prokaryoten“</td>
</tr>
<tr>
<td>Lehrsprache:</td>
<td>deutsch</td>
</tr>
<tr>
<td>Gruppengröße:</td>
<td>12</td>
</tr>
<tr>
<td>Modulende:</td>
<td>1 Semester, Block</td>
</tr>
<tr>
<td>Fachsemester:</td>
<td>2</td>
</tr>
<tr>
<td>Angebots-häufigkeit:</td>
<td>Nur im Sommersemester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SWS</th>
<th>Präsenzstudium</th>
<th>Selbststudium</th>
<th>Workload Summe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30 h</td>
<td>30 h</td>
<td>60 h</td>
</tr>
</tbody>
</table>

### Inhalte

Die Vorlesungseinheiten behandeln die theoretischen Grundlagen zu den in den Übungen durchzuführenden experimentellen Untersuchungen und angrenzende Bereiche:

- Rekombinante DNA-Techniken
- Regulation der Genexpression in Bakterien und Archaeen
- Vom Gen zum Genprodukt: Ebenen der Regulation
- Anpassung an Umweltveränderungen
- Lichtwahrnehmung über Photorezeptoren
- Assembling und Aufreinigung von membranständigen Multiproteinkomplexen
- Lichtsammlung und Photosynthese
- Motilität in Archaeen

### Lehrmethoden und Medien

- Frontalvortrag im Wechsel mit Diskussionen und Fragerunden sowie kurzen Tests
- Medien: Tafel, PowerPoint-Präsentation, Arbeitsblätter, TED-System

### Lernziele / Lernergebnisse

Die Studierenden

- können die Grundprinzipien, die der bakteriellen und archaealen Genregulation zugrunde liegen, erläutern und diese beispielhaft diskutieren
- kennen verschiedene Anpassungsmechanismen, mit denen Bakterien und Archaeen die zelluläre Homöostase unter veränderten Umweltbedingungen aufrecht erhalten
- können komplexe zellphysiologische Anpassungen als Realisierung hochentwickelter regulatorischer Mechanismen beschreiben
- können Prinzipien der Rückkopplungsmechanismen zwischen äußeren Stimuli, Stoffwechsel und Genregulation an Fallbeispielen diskutieren
- können die spezifischen Stoffwechselleistungen und Anpassungsfähigkeiten photosynthetischer Organismen einschätzen und mit anderen Organismen vergleichen
- können verschiedene Oberflächenstrukturen von Archaeen und Bakterien unterscheiden

### Studienleistung

Selbständiges Nacharbeiten der Inhalte der Vorlesungen

### Prüfungsleistung & Benotung

keine

### Literatur

- Watson, "Molekularbiologie"
- B. Lewin "Genes X"
**Veranstaltungstitel:** Vom Signal zum Aufbau von Multiproteinkomplexen  

**Lehrform:** Übung  

**Modul:** Wahlmodul „Molekularbiologie der Prokaryoten“ WM-11  

**Verwendbarkeit:** Wahlmodul „Molekularbiologie der Prokaryoten“  

**Lehrsprache:** deutsch  

**Gruppengröße:** 12  

**Moduldauer:** 1 Semester, Block  

**Fachsemester:** 2  

**Angebots-häufigkeit:** Nur im Sommersemester  

<table>
<thead>
<tr>
<th>SWS</th>
<th>Präsenzstudium</th>
<th>Selbststudium</th>
<th>Workload Summe</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>60 h</td>
<td>90 h</td>
<td>150 h</td>
</tr>
</tbody>
</table>

**Inhalte**  
In den Übungen werden aktuelle wissenschaftliche Fragestellungen mit Hilfe moderner molekularer, genetischer und biochemischer Experimente bearbeitet. Es wird die Reaktion eines Bakteriums auf äußere Reize über ein ausgewähltes bakterielles Signalsystem untersucht:  
- Quantifizierung der Expression von Genen, die unter Kontrolle eines durch Licht regulierten Signalsystems stehen  
- Physiologische und biochemische Untersuchungen zur Anpassungsfähigkeit von Organismen an veränderte Umweltbedingungen  
- Quantifizierung von Anpassungsreaktionen auf Ebene der Proteine und Pigmente  
- Isolation und Untersuchung von membranständigen Multiproteinkomplexen (Antennenkomplexe und Photosysteme)

**Lehrmethoden und Medien**  
Laborarbeit als Einzel- und Partnerarbeit  
Medien: ausführliches Skript, Tafelbild, Demonstrationen

**Lernziele / Lernergebnisse**  
Die Studierenden:  
- kennen die Methoden, mit denen molekulare Prozesse der Signaltransduktion in Bakterien untersucht werden können, insbesondere mit Blick auf  
  - funktionelle Analyse von Mutanten  
  - Signaltransduktionsketten  
  - Signalverarbeitung  
  - Assembling von Multiproteinkomplexen  
- erlangen die Fähigkeit, mit Hilfe der erlernten Methoden und experimentellen Ansätze eigene Ergebnisse kritisch zu bewerten und Schlussfolgerungen zu ziehen

**Studienleistung**  
- Regelmäßige Teilnahme, mindestens 80% Anwesenheitszeit, versäumte Versuche müssen nachgeholt werden  
- Protokoll

**Prüfungsleistung & Benotung**  
keine

**Literatur**  
Praktikumsskript
Veranstaltungstitel: Molekulare und biochemische Methoden

Lehrform: Seminar

Modul: Wahlmodul „Molekularbiologie der Prokaryoten“ WM-11

Verwendbarkeit: Wahlmodul „Molekularbiologie der Prokaryoten“

Lehrsprache: deutsch

Gruppengröße: 12

Moduldaumer: 1 Semester, Block

Fachsemester: 2

Angebots-häufigkeit: Nur im Sommersemester

<table>
<thead>
<tr>
<th>SWS</th>
<th>Präsenzstudium</th>
<th>Selbststudium</th>
<th>Workload Summe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 h</td>
<td>45 h</td>
<td>60 h</td>
</tr>
</tbody>
</table>

Inhalte
Im Seminar werden englischsprachige Originalpublikationen im Bereich Molekularbiologie und Biochemie vorgestellt. Hauptschwerpunkt liegt auf der Darstellung und Erläuterung der verwendeten Methoden.

Lehrmethoden und Medien
Einzelarbeit, Diskussion
PowerPoint-Präsentationen.

Lernziele / Lernergebnisse
Die Studierenden
• sind in der Lage, aktuelle Publikationen auf dem Gebiet der Molekularbiologie der bakteriellen Signaltransduktion zu verstehen und Fragestellungen und Untersuchungsergebnisse wiedzugeben.

Studienleistung
• Vorbereiten eines Seminarvortrags
• Mündliche Präsentation eines Seminarthemas
• Regelmäßige Teilnahme, mindestens 80% Anwesenheitszeit

Prüfungsleistung & Benotung
keine

Literatur
Aktuelle englischsprachige Originalliteratur wird zur Verfügung gestellt.

Weitere Informationen:
Der Seminarvortrag kann auch auf Englisch gehalten werden.
**Module:** Biology II - The cell at high resolution

<table>
<thead>
<tr>
<th>Responsible person:</th>
<th>Department(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Römer, Winfried</td>
<td>Cell biology</td>
</tr>
</tbody>
</table>

**Type:** Elective module  
**Recommended semester:** 2  
**Duration:** 1 semester, block course  
**ECTS:** 9  
**Recurrency frequency:** Summer semester  
**Workload:** 270 h  

**Applicability:**  
M.Sc. Biology: elective module A in the Majors Translational Biology and Plant Sciences  
M.Sc. Biochemistry and Biophysics: as elective module Biology II

**Teachers:** Claudinon, Julie / Madl, Josef / Römer, Winfried / Thünauer, Roland / Ulbrich, Maximilian

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell biology at high temporal and spatial resolution</td>
<td>Lecture</td>
<td>3</td>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>High resolution microscopy techniques</td>
<td>Practical exercise</td>
<td>5</td>
<td>4.2</td>
<td>150</td>
</tr>
<tr>
<td>Biological applications of high-resolution microscopy techniques</td>
<td>Seminar</td>
<td>1</td>
<td>0.7</td>
<td>30</td>
</tr>
</tbody>
</table>

**Goals**  
The students acquire comprehensive knowledge and practical experience along various cellular processes and their analysis by high/super resolution microscopy. The students master to  
- define the major endocytic mechanisms and pathways  
- choose the appropriate tools to stain cellular molecules and compartments  
- describe polarized cells and vesicular trafficking  
- define and select inhibitors against cellular molecules and processes  
- explain the principles of fluorescence microscopy and the anatomy of microscopes  
- explain confocal microscopy, total internal reflection microscopy, and compare the advantages and disadvantages of both  
- conduct an immunofluorescence experiment  
- acquire images with different microscopes  
- prepare membrane model systems  
- explain the principles of optogenetics and its applications in biology  
- illustrate the principles of super resolution fluorescence techniques  
- explain the principles of atomic force microscopy  
- define the principles of single molecule tracking

**Achievements**  
- Attendance at lectures, exercises and seminars (minimum 80%)  
- Active participation  
- Autonomous revision of lectures  
- Preparation and presentation of a seminar

**Exams**  
none

**Literature**  
No particular textbooks will be used. Lectures are mostly based on recent review articles.
Course: Cell biology at high temporal and spatial resolution

Type: Lecture

Module: Wahlmodul „The cell at high resolution“ | WM-21

Applicability: Wahlmodul „The cell at high resolution“
M.Sc. Biochemistry and Biophysics: as elective module Biology II

Language: English

Number of participants:
- 8 (M.Sc. Biology)
- 4 (M.Sc. Biochemistry & Biophysics)

Duration: 1 semester, block course

Recommended semester: 2

Recurrency frequency: Only in summer semester

SWS | Workload contact time | Workload self-study | Total workload
--- | --- | --- | ---
3 | 45 h | 45 h | 90 h

Contents
The lectures give a comprehensive overview of various cell biology topics and high/super resolution microscopy techniques covering the following areas:
- Endocytosis
- Vesicular trafficking
- Cellular compartments
- Polarized cells
- Fluorescence microscopy (widefield microscopy, confocal microscopy, TIRF microscopy, FRET, FLIM, FRAP)
- Super resolution fluorescence microscopy (STED, SIM, PALM, STORM)
- Single molecule tracking
- Atomic force microscopy
- Optogenetics

Teaching methods and media
Lectures will be given by several motivated lecturers from different faculties. Mostly, Powerpoint-presentations will be used and hand-outs will be provided.

Goals
The students acquire comprehensive knowledge along cellular processes and their analysis by high/super resolution microscopy. The students master to:
- Define the major endocytic mechanisms and pathways
- Select appropriate tools to stain cellular molecules and compartments
- Define inhibitors against cellular molecules and processes
- Explain the principles of fluorescence microscopy and the anatomy of microscopes
- Explain confocal microscopy, total internal reflection microscopy, and compare the advantages and disadvantages of both
- Define some types of synthetic membrane systems
- Explain the principles of optogenetics and its applications in biology
- Define polarized cells and vesicular trafficking
- Illustrate the principles of some super resolution fluorescence techniques
- Explain the principles of atomic force microscopy
- Define the principles of single molecule tracking

Achievements
- Attendance at lectures (minimum 80%)
- Active participation
- Autonomous revision of lectures

Exams
none

Literature
No particular textbooks will be used. Lectures are mostly based on recent review articles.
Course: High resolution microscopy techniques

Type: Practical exercise

Module: Wahlmodul „The cell at high resolution“ WM-21

Applicability: Wahlmodul „The cell at high resolution“
M.Sc. Biochemistry and Biophysics: as elective module Biology II

Language: English

Number of participants: 8 (M.Sc. Biology)
4 (M.Sc. Biochemistry & Biophysics)

Duration: 1 semester, block course

Recommended semester: 2

Recurrency frequency: Only in summer semester

<table>
<thead>
<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2</td>
<td>63 h</td>
<td>87 h</td>
<td>150 h</td>
</tr>
</tbody>
</table>

Contents

Comprehensive practical experience will be gained in different cell biology and microscopy techniques:
- Transfection of mammalian cells and *Xenopus* oocytes
- Endocytosis experiment with different cargos
- Chemical fixation
- Permeabilization
- Labeling with antibodies
- Embedding
- Imaging of fixed and living cells by using different microscopy techniques
- Formation of liposomes
- Micro-injection

Teaching methods and media

The students will be divided into small groups, mostly tandems, which do the experiment and the acquisitions together. The research topics and the work plans will be introduced by PowerPoint presentations or on the whiteboard.

Goals

The students acquire practical experience along various cellular processes and their analysis by high resolution microscopy techniques. In particular, the students master to:
- conduct an immunofluorescence experiment
- acquire images with different microscopes and in real-time
- identify cellular compartments
- prepare and image synthetic lipid bilayers
- perform micro-injection

Achievements

- Attendance at exercises (minimum 80%)
- Active participation

Exams

none

Literature

No particular textbooks will be used. Links to excellent review articles on microscopy techniques will be provided.
### Course: Biological applications of high resolution microscopy techniques

<table>
<thead>
<tr>
<th><strong>Type:</strong></th>
<th>Seminar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module:</strong></td>
<td>Wahlmodul „The cell at high resolution“ WM-21</td>
</tr>
</tbody>
</table>
| **Applicability:** | Wahlmodul „The cell at high resolution“  
M.Sc. Biochemistry and Biophysics: as elective module Biology II |
| **Language:**      | English                  |
| **Number of participants:** | 8 (M.Sc. Biology)  
4 (M.Sc. Biochemistry & Biophysics) |
| **Number of participants:** | 8 (M.Sc. Biology)  
4 (M.Sc. Biochemistry & Biophysics) |
| **Duration:**      | 1 semester, block course |
| **Recommended semester:** | 2 |
| **Recurrency frequency:** | Only in summer semester |
| **SWS**            | 0,7                      |
| **Workload contact time** | 10,5 h          |
| **Workload self-study** | 19,5 h          |
| **Total workload** | 30 h                     |

### Contents
The students choose and present recently published articles that highlight biological questions by using high/super resolution microscopy techniques. Various biological processes and microscopy techniques will be presented.

### Teaching methods and media
The students present their selected research topics on the basis of a PowerPoint presentation followed by a discussion.

### Goals
The presentations done by students will provide complementary information to the lectures and exercises on various biological processes and state-of-the-art microscopy techniques. The students master to
- identify high quality publications
- summarize the most important findings
- analyze critically the content and applied techniques
- give a structured presentation
- lead a discussion

### Achievements
- Attendance at seminars (minimum 80%)
- Active participation
- Preparation and presentation of a seminar

### Exams
none

### Literature
No particular textbooks will be used. Students will select recently published research articles for their presentations.
## Module: Biologie II - Cell-free synthesis of proteins and label-free detection of protein-protein interactions

<table>
<thead>
<tr>
<th>Responsible person:</th>
<th>Department(s):</th>
</tr>
</thead>
</table>

### Type: Elective module
### Recommended semester: 2
### Duration: 1 semester, block course
### ECTS: 9
### Recurrency frequency: Summer semester
### Workload: 270 h
### Recommended qualification:
### Requirements:
### Applicability: M.Sc. Biochemistry and Biophysics: as elective module Biology II
### Teacher: G. Roth

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>ECTS</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell-free synthesis of proteins and label-free detection of protein-protein interactions</td>
<td>VL and Pr</td>
<td>9</td>
<td>8</td>
<td>270</td>
</tr>
</tbody>
</table>

**Goals**
see course description below

**Achievements**
see course description below

**Exams**
None

**Literature**
### Course: Cell-free synthesis of proteins and label-free detection of protein-protein interactions

**Type:** Lecture and Practical Course

**Module:** Cell-free synthesis of proteins and label-free detection of protein-protein interactions

**Applicability:** Cell-free synthesis of proteins and label-free detection of protein-protein interactions  
M.Sc. Biochemistry and Biophysics: as elective module Biology II

**Language:** On request English, else German

**Number of participants:** 2

**Recommended semester:** 2

**Duration:** 4 weeks

**Recurrency frequency:** Only in summer semester

<table>
<thead>
<tr>
<th>SWS</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>Total workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>270 h</td>
</tr>
</tbody>
</table>

**Contents**

Cell-free mix is used for protein generation like PCR mix is used for DNA generation. Basically it is an enzymatic mix, containing all ingredients to produce proteins as soon as correctly programmed DNA is mixed into it. Even if first mixes have been used to decode the genetic code nearly 60 years ago, the method is rarely used. But as no cell culturing is needed at all, it is an upcoming revival of this technique to produce proteins on demand, simply from DNA. To measure interactions of this protein with others also a best label-free detection method is of interest. We apply the so called “imaging Reflectometric Interference Spectroscopy” system (iRIfS) to realize a label-free real-time monitoring of binding interactions.

In the first week each morning a 2 h lecture about the basics of the cell-free biosynthesis of proteins and label-free detection systems will be given. In the afternoon first experiments and device introductions are made. The following weeks each student gets a small own project to realize the whole workflow:

- How to select the DNA sequences?
- Generate the DNA template for cell-free expression
- Quality control of the DNA template
- Classic expression in cells and cell-free expression of the protein
- Quality control and/or purification of the protein
- Performing an binding interaction under label-free detection of the protein

This shall enable the students to get basic skills about the label-free detection systems and an understanding how a protein can be theoretically and practically be generated and in case of cell-free expression used without any need for cell culturing.

**Teaching methods and media**

- Lectures media: PowerPoint-Presentations, handouts
- Lab course: Hands on experience in cell-free protein expression and label-free detection iRIfS

**Goals**

The students are able to

- Understand the theory of different label-free detection methods
- Have the ability to select between different label-free detection systems in dependence of their aimed analysis goal
- Design and generate proteins via cell-free expression

**Achievements**

Active participation in lectures

**Exams**

None

**Literature**

- Watson: Molecular Biology of the Gene
- Lewin: Genes
- Alberts: Molecular Biology of the Cell
- Gomberts: Signal Transduction (2nd Ed)
# Module

## Biochemistry II

**Department**

Biochemistry (chemical department)

**Recommended semester:**

2. FS

**6 ECTS CP**

<table>
<thead>
<tr>
<th>Courses</th>
<th>Type</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>P/W</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Lecture series („Ringvorlesung“)</td>
<td>S</td>
<td>60 h</td>
<td>60 h</td>
<td>P</td>
<td>4</td>
</tr>
<tr>
<td>b. Advanced seminar („Oberseminar“)</td>
<td>S</td>
<td>30 h</td>
<td>30 h</td>
<td>P</td>
<td>2</td>
</tr>
</tbody>
</table>

**Responsible person**

Prof. Dr. T. Friedrich

**Teachers**

The lecturers from Biochemistry, Chemistry, Biology and Pharmaceutical sciences

**Recurrency frequency**

every SS

**Language**

German/English

**Requirements**

The module „Biochemistry Lab Course“ has to be passed before giving the seminar presentation.

**Goals**

**Contents**

Lecture series („Ringvorlesung“)

The work groups of the teachers that are involved in the M.Sc. program present their research topics and goals.

Advanced seminar („Oberseminar“) Biochemistry

Each work group assigns 1-2 topics for a presentation that the students prepare over the semester and present during the last weeks before the semester break

**Achievements and Exams**

SL: mandatory attendance of lecture series a.

PL: seminar presentation

**Literature**
**Module**  
**Master Laboratory Course – Advanced („Vertiefungspraktikum“)**

**Department**

**Recommended semester:** 3. FS  
**12 ECTS CP**

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>Workload</th>
<th>Workload</th>
<th>P/ WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Laboratory Course – Advanced („Vertiefungspraktikum“)</td>
<td>Pr</td>
<td>300 h</td>
<td>60 h</td>
<td>P</td>
<td>9</td>
</tr>
</tbody>
</table>

**Responsible person**  
Prof. Dr. T. Friedrich, or any teacher that is involved in the M.Sc. program Biochemistry and Biophysics. If already known, it makes sense to choose the intended supervisor of the master thesis.

**Teachers**

**Recurrency frequency**  
Always, independent of lecture periods.

**Language**  
German/English

**Requirements**  
The module „Biochemistry Lab Course“ has to be passed before.

In consultation with a chosen supervisor or with the responsible person, the course may take place in industry or at a different university or research facility. However, the "Master Laboratory Course - Advanced" should be supervised by (or, in case it is done at an external institution, coordinated with) a teacher who is involved in the M.Sc. program. This supervisor may be a member of the faculty of Chemistry and Pharmacy, the faculty of Biology, the faculty of Engineering, the faculty of Mathematics and Physics or the University of Strasbourg. Exceptions to this rule must be approved by the examination committee ("Masterprüfungsausschuss").

**Goals**  
During the master laboratory course, the students learn how to work independently, using scientific methods in order to obtain information that is relevant for research.

**Contents**  
Complex facts and issues are imparted based on the knowledge obtained in the previous courses. The students are introduced to sophisticated applications of scientific methods, which are adapted to state-of-the-art research. A solid basis for independent scientific working is created, preparing the students for the upcoming research training laboratory and the master thesis.

**Achievements and Exams**  
PL: Report, presentation or oral exam (in consultation with the supervisor or the responsible person).

**Literature**
Module  
Research Training Laboratory  
(“Forschungspraktikum”)

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>P/ WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Training Laboratory</td>
<td>Pr</td>
<td>400 h</td>
<td>50 h</td>
<td>P</td>
<td>12</td>
</tr>
</tbody>
</table>

**Responsible person**  
Prof. Dr. T. Friedrich, or any teacher that is involved in the M.Sc. program Biochemistry and Biophysics. If already known, it makes sense to choose the intended supervisor of the master thesis.

**Teachers**

**Recurrency frequency**  
Always, independent of lecture periods.

**Language**  
German/English

**Requirements**  
The module „Biochemistry Lab Course“ has to be passed before.

In consultation with a chosen supervisor or with the responsible person, the course may take place in industry or at a different university or research facility.

However, the “Master Laboratory Course - Advanced” should be supervised by (or, in case it is done at an external institution, coordinated with) a teacher who is involved in the M.Sc. program. This supervisor may be a member of the faculty of Chemistry and Pharmacy, the faculty of Biology, the faculty of Engineering, the faculty of Mathematics and Physics or the University of Strasbourg. Exceptions to this rule must be approved by the examination committee (“Masterprüfungsausschuss”).

**Goals**

The students get used to working their way into different fields of biochemistry and biophysics. They learn how to read, question, understand and write scientific articles. In the end, they are able to apply their expert knowledge in a new, unfamiliar and multidisciplinary context within the field.

**Contents**

Preparation of and initial training for the master thesis. In consultation with the thesis supervisor, the course may take place in industry or at a different university or research facility.

**Achievements and Exams**

SL: Report or presentation (in consultation with the supervisor or the responsible person).

**Literature**
## Module

### Methods and Concepts („Methoden und Konzepte“)

**Department**

**Recommended semester:** 1. – 4. FS

<table>
<thead>
<tr>
<th>Type</th>
<th>Workload contact time</th>
<th>Workload self-study</th>
<th>P/WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective courses:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All courses that are part of the other modules (which you did **not** choose) and all elective courses within this M.Sc. program.

Special/advanced lectures and lab courses according to the offer in the course catalog.

Special/advanced lectures and lab courses outside the universities of Freiburg and Strasbourg in consultation with the responsible person.

In addition:

a. Nanomechanical and topographical imaging of biological membranes using atomic force microscopy

b. Data collection and some statistics

### Responsible person

Prof. Dr. T. Friedrich

### Teachers

a. Prof. Römer
d. Dr. Roth

### Recurrency frequency

Every semester, according to the offer in the course catalog.

### Language

German/English

### Requirements

None

### Goals

The students learn about various methods and concepts. They are able to handle instruments and evaluate data independently.

### Contents

Diverse subject areas beyond the curriculum.

### Achievements and Exams

SL: in consultation with the supervisor of the individual course or with the responsible person

1 ECTS Credit Point equals a workload of 30 h

### Literature
Module  
Master thesis

Department

Recommended semester:  4. FS

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>Workload</th>
<th>Workload</th>
<th>P/WP</th>
<th>SWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master thesis</td>
<td>Pr</td>
<td>800 h</td>
<td>100 h</td>
<td>P</td>
<td>15</td>
</tr>
</tbody>
</table>

**Responsible person**  
Supervisor of the master thesis

**Teachers**

**Recurrency frequency**  
Always, independent of lecture periods.

**Language**  
German/English

**Requirements**  
The following modules have to be passed before:

Biochemistry Lab Course  
Biochemistry I  
Biochemistry II  
Biophysics  
Bioinformatics  
Biology I  
Biology II  
Masters Laboratory Course – Advanced  
Research Training Laboratory

**Goals**  
The students learn how to read, question, understand and write scientific articles. In the end, they are capable of applying their expert knowledge in a new, unfamiliar and multidisciplinary context. They are able to apply modern techniques and to plan, execute and document experiments independently.

**Contents**  
The master thesis is a scientific project, in which the candidate is guided concerning topic, content and methods. It is connected to a particular field of research and it is supposed to be kept simple. The thesis is guided by two supervisors. One of them must be Professor at the University of Freiburg or Strasbourg ("Referent").  
The master thesis is supposed to be done in a workgroup that is involved in the M.Sc. program. This may be at the faculty of Chemistry and Pharmacy, the faculty of Biology, the faculty of Engineering, the faculty of Mathematics and Physics or the University of Strasbourg. Exceptions to this rule must be approved by the examination committee ("Masterprüfungsausschuss").

**Achievements and Exams**  
PL: written master thesis (in English or German)

**Literature**
Appendix:

**Contact persons:**

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