### Master Molecular Biology and Biotechnology

<table>
<thead>
<tr>
<th>Module MBT</th>
<th>Title</th>
<th>Type</th>
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# Module: Biochemistry

<table>
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<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration</th>
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<tbody>
<tr>
<td>MBT 114</td>
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<table>
<thead>
<tr>
<th>Person in charge of the module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. Dieter Fürst, Institut für Zellbiologie</td>
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</table>

<table>
<thead>
<tr>
<th>Teaching unit(s) offering the module</th>
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<tbody>
<tr>
<td>Biology</td>
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<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>1st semester</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lecture provides basic knowledge about biochemical processes. Students will gain insight into the molecules that comprise biological systems and their processing in major metabolic pathways. Lectures about biochemical methods shall complement the contents of practical courses. The practical imparts elementary biochemical techniques.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key skills qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key skills qualifications promoted by the lecture are communication, project planning and management, team work in learning groups, interpretation skills, literature management, working towards targets and on deadlines, communicating own needs, accepting constructive feedback.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture: protein biochemistry, enzymology, metabolic pathways, lipids, biochemical methods. Practical: protein extraction, ammonium sulfate precipitation, ADH activity, cell fractioning, key enzymes, immuno precipitation, in vitro reconstitution of cellular processes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolment to the programme</td>
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<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<table>
<thead>
<tr>
<th>Examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of examination</td>
</tr>
<tr>
<td>Lecture: written examination</td>
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<tr>
<td>Practical: report</td>
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<table>
<thead>
<tr>
<th>Study elements required as prerequisite for admission to the module examination</th>
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<tbody>
<tr>
<td>Participation in the practical exercise</td>
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As of 17th November 2015
### Module: Biochemistry

<table>
<thead>
<tr>
<th>Additional information</th>
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As of 17th November 2015
**Module: Molecular Biology 1**

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration</th>
<th>Offered</th>
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<tbody>
<tr>
<td>MBT 115</td>
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<td>1 semester</td>
<td>Winter semester</td>
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- **Person in charge of the module**: Prof. Dr. Walter Witke, Institut für Genetik
- **Teaching unit(s) offering the module**: Biology

### Applicability of the module

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>1st semester</td>
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</tbody>
</table>

### Teaching aims

The lecture provides basic knowledge of Molecular Biology. Students will gain insights into the molecular mechanisms of biological processes. As biological processes, we define all processes which enable cells to live and propagate and to contribute to a functioning multicellular organism.

The practical provides insights into basic and advanced techniques in molecular biology.

### Key skills qualifications

Key skills promoted by the lecture are communication skills, project planning and management, teamwork, scientific interpretation, literature management, working towards targets and on deadlines, hypothesis driven approaches in science, scientific ethics.

### Contents

The following contents will be covered by the lectures:

- Nucleic Acids as the basis of life (Structure, Replication, Transcription)
- Genetics of Phenotypic Inheritance
- Translation of Genetic Information
- Mechanisms of Gene Expression
- Proteins (Structure and Function)
- Protein Stability and Degradation
- Signal Transduction Pathways
- Cellular Organization and the Cytoskeleton
- Stem Cell Physiology
- Development and Homeostasis of Tissues
- Model Organisms in Biology

The practical comprises: isolation of molecules (RNA) from animal cells or tissues, reverse transcription PCR, gene specific PCR reactions, quantitative real-time PCR, gel electrophoresis, quantitative real time PCR and end point PCR data analysis, candidate gene analysis with *in situ* hybridization (ISH), fragment sequencing, sequence data analysis, use of public data bases.

### Prerequisites for participation

Enrolment to the M.Sc. programme. For students of other programs or exchange students - admission by the 'Programme Board'.

*As of 17th November 2015*
# Module: Molecular Biology 1

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<table>
<thead>
<tr>
<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
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<tbody>
<tr>
<td></td>
<td>written examination</td>
<td>graded</td>
</tr>
<tr>
<td></td>
<td>practical report</td>
<td>graded</td>
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| Study elements required as prerequisite for admission to the module examination | graded / not graded |

<table>
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<tr>
<th>Additional information</th>
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# Module: Biotechnology 1

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<table>
<thead>
<tr>
<th>Person in charge of the module</th>
<th>Prof. Dr. Erwin Galinski, Institut für Mikrobiologie und Biotechnologie</th>
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<td>Teaching unit(s) offering the module</td>
<td>Biology</td>
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<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>1st semester</td>
</tr>
</tbody>
</table>

| Teaching aims | The lecture provides insights into fundamental aspects of microbial biotechnology, including fermentation technologies, scale-up and downstream processing, overproduction and biotransformation, heterologous expression of proteins, environmental biotechnology. The practical imparts elementary techniques of microbial biotechnology in the context of heterologous protein expression, including the construction of vectors, choice of promoter, application of fusion tags and subsequent downstream processing. |

| Key skills qualifications | Key skills qualifications promoted by the lecture are communication, project planning and management, teamwork in learning groups, interpretation skills, literature management, working towards targets and on deadlines, communicating own needs, accepting constructive feedback. |

<table>
<thead>
<tr>
<th>Contents</th>
<th>The lecture covers the topics:</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>• Types of bioreactors;</td>
</tr>
<tr>
<td></td>
<td>• Design of media composition;</td>
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<tr>
<td></td>
<td>• Control of fermentation process;</td>
</tr>
<tr>
<td></td>
<td>• Fermentation strategies (batch, fed-batch, dialysis, continuous culture);</td>
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<td></td>
<td>• Downstream processing;</td>
</tr>
<tr>
<td></td>
<td>• Overproduction (citric acid, glutamate, lysine);</td>
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<tr>
<td></td>
<td>• Biotransformations;</td>
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<tr>
<td></td>
<td>• Heterologous expression of proteins;</td>
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<tr>
<td></td>
<td>• Enzymes and biosensors;</td>
</tr>
<tr>
<td></td>
<td>• Production and degradation of biopolymers;</td>
</tr>
<tr>
<td></td>
<td>• Bioremediation of water and soil</td>
</tr>
</tbody>
</table>

The practical comprises: |

• Selection of appropriate expression system depending on target protein; |
• PCR amplification of target protein and construction of vector with suitable promoter; |
• Heterologous expression of target protein in *Escherichia coli* using mini-fermenters for controlled bacterial growth; |
### Module: Biotechnology 1

- Isolation and purification of target protein with the help of fusion tags;
- Confirmation of activity/functionality of target protein.

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
<th>Enrolment to the programme</th>
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<table>
<thead>
<tr>
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<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
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<th>Type of examination</th>
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<td>graded</td>
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<tr>
<td>Practical exercise</td>
<td>written examination</td>
<td>graded</td>
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</table>

| Study elements required as prerequisite for admission to the module examination | Regular participation (lecture and seminar), team presentation of biotechnological topic in seminar, regular attendance of the practical. | graded / not graded |

| Additional information | prerequisite for admission to optional modules "Extremophilic Microorganisms" |

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As of 17th November 2015
# Module: Skills Lab / Bioethics

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
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<th>Duration</th>
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**Person in charge of the module**
Dr. Karl Peter Linscheid, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)

**Teaching unit(s) offering the module**
Biology

**Applicability of the module**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>1st semester</td>
</tr>
</tbody>
</table>

**Teaching aims**

Skills Lab: current methods of data processing and visualization, literature research and management, scientific writing and presentation.

Bioethics: selected literature on bio- and research ethics is used to make the students familiar with principles of ethical judgements with regard to bioscientific research and applications. The participants will be motivated to reflect on and analyze the ethical dimension of their own biotechnological fields of work and activities. The aim of the course is for the students to perceive ethical reflection as an integral element of their education and future work.

**Key skills qualifications**

Key skills qualifications promoted by the elements of the module are communication, project planning and management, teamwork, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems.

**Contents**

Current Topics: The course consists of

- a lecture about text processing, formatting and layout, writing style in the life sciences, method of scientific citation, literature research and management, spreadsheet processing and diagrams, image processing and analysis, scientific posters and presentation. overview of free and open source software,

- a seminar presentation by each student about a selected current topic in molecular biotechnology, and

- writing a scientific paper about the topic.

Bioethics: Bioethical problems of biotechnological processes in food production, agriculture, animal breeding, medicine.

**Prerequisites for participation**
Enrolment to the programme

**Course elements**

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tr>
<td>Seminar</td>
<td>Bioethics</td>
<td>25</td>
<td>2</td>
<td>60</td>
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As of 17th November 2015
## Module: Skills Lab / Bioethics

<table>
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<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
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<tbody>
<tr>
<td>Skills Lab</td>
<td>Written review or poster about a current topic</td>
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</tr>
<tr>
<td>Bioethics</td>
<td>Seminar presentations, semester paper</td>
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- Study elements required as prerequisite for admission to the module examination: graded / not graded
- Additional information: 

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As of 17th November 2015
## Module: Practical Course in Research Laboratories or Industry

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<td>Extent</td>
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<td>Offered</td>
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<tr>
<td>Person in charge of the module</td>
<td>Dr. Karl Peter Linscheid, IMBIO</td>
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<tr>
<td>Teaching unit(s) offering the module</td>
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### Applicability of the module

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>2nd semester</td>
</tr>
</tbody>
</table>

### Teaching aims

In addition to the technological aspects of the project work, the students (especially in industrial companies) learn to assess to what extent non-technological parameters like location, infrastructure, market share, management style, workflow, social interactions, affect the success of biotechnological production.

### Key skills qualifications

Key skills qualifications promoted by the project work are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control, managing off-campus accommodation.

### Contents

Practical insight into operational procedures.

### Prerequisites for participation

Enrolment to the M.Sc. programme. For students of other programmes or exchange students - admission by the 'Programme Board'.

### Course elements

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
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<th>SWS</th>
<th>Workload [h]</th>
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<tr>
<td>Practical</td>
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### Examinations

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### Study elements required as prerequisite for admission to the module examination

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### Additional information

As of 17th November 2015
# Module: Molecular Biology 2

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<td>180 h</td>
<td>6 SWS</td>
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**Person in charge of the module**
Prof. Dr. Walter Witke, Institut für Genetik

**Teaching unit(s) offering the module**
Biology

## Applicability of the module

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>2nd semester</td>
</tr>
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</table>

## Teaching aims
The lecture provides advanced knowledge of Molecular Biology. Students will gain insights into molecular mechanisms of communication, regulation, differentiation, development and disease. The practical course will provide insights into advanced techniques used in molecular biology. The students should learn methods and gain experience in planning and performing experiments independently.

## Key skills qualifications
Key skills promoted by the lecture are communication skills, project planning and management, team work, scientific interpretation, literature management, working towards targets and on deadlines, hypothesis driven approaches in science, scientific ethics.

## Contents
The following contents will be covered by the Lectures:
- Tumor cell biology (Probstmeier)
- Oxidative stress and DNA damage (Golubnitschaja)
- Genetic Model Systems (Gomeza)
- Molecular cell biology (Fürst)
- Signal Transduction; Cytoskeleton (Rottner)
- Stem cells; Transgenic Mammals (M. Hölker)

The following contents will be covered by the practical:
- Nucleic Acid Purification
- Expression of Recombinant Proteins
- Protein Purification
- Cell Culture Techniques
- Cell Transfection
- Gene Expression Studies
- Microscopic Imaging Techniques
- Control of Gene Expression

## Prerequisites for participation
Enrolment to the M.Sc. programme. For students of other programmes or exchange students - admission by the 'Programme Board'.

*As of 17th November 2015*
### Module: Molecular Biology 2

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tbody>
<tr>
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#### Examinations

<table>
<thead>
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<tbody>
<tr>
<td>Lecture written examination</td>
<td>graded</td>
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<tr>
<td>Practical exercise practical report</td>
<td>graded</td>
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#### Study elements required as prerequisite for admission to the module examination

<table>
<thead>
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<th>graded / not graded</th>
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#### Additional information

As of 17th November 2015
Module: Biotechnology 2

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration</th>
<th>Offered</th>
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</thead>
<tbody>
<tr>
<td>MBt 127</td>
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<td>5 SWS</td>
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<td>Summer semester</td>
</tr>
</tbody>
</table>

**Person in charge of the module**
Prof. Dr. Dorothea Bartels, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)

**Teaching unit(s) offering the module**
Biology

**Applicability of the module**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>2nd semester</td>
</tr>
</tbody>
</table>

**Teaching aims**
The lecture provides insights into plant, pharmaceutical, medical biotechnology.
The practical aims at application of basic working techniques for plant cell and tissue culture and sterile work at the laminar air flow bench, enabling the participants to cultivate various cell and tissue cultures on suitable media.

**Key skills qualifications**
Key skills qualifications promoted by the lecture and practical are communication, project planning and management, team work in learning groups, interpretation skills, literature management, working towards targets and on deadlines, communicating own needs, accepting constructive feedback.

**Contents**
The lecture comprises:

- Plant transformation technologies, metabolic engineering, generation of stress tolerant plants
- Plant tissue culture methods; engineering of plant lipid metabolism and herbicide resistance
- Structure and function of biological surfaces, biofilms: formation, development and properties of biofilms; occurrence in natural, industrial and hospital settings, biotechnological aspects of biofilms, examples of biofilm-associated diseases, biofilms in dentistry (pathology and treatment).
- Biotechnology of molecular diagnostics, predictive and personalized medicine.
- Natural active compounds from plants and microorganisms.
- Antibodies (ABs) – structure, types, genetics, function, usage, basic immunobiology; production and use of poly- and monoclonal ABs, IgY, hclG etc., AB engineering and recombinant ABs, tags and labels, labeling techniques, immunocyto-/histo-/chemistry, immunophenotyping, flow cytometry, immunoassays, AB-based diagnostics, therapeutic use of ABs, immunotoxins.

The practical exercise covers: protoplast isolation, suspension cultures, sterilization, regeneration problems

**Prerequisites for participation**
Enrolment to the programme.

As of 17th November 2015
# Module: Biotechnology 2

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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</thead>
<tbody>
<tr>
<td>Lecture</td>
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<th>graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture, seminar</td>
<td>written examination</td>
<td>graded</td>
</tr>
<tr>
<td>Practical exercise</td>
<td>practical report</td>
<td>graded</td>
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</table>

| Study elements required as prerequisite for admission to the module examination | graded / not graded |

| Additional information | |
### Module: Introduction to Bioinformatics

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration</th>
<th>Offered</th>
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</thead>
<tbody>
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<td>MBT 133</td>
<td>150 h</td>
<td>5 SWS</td>
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<td>Winter semester</td>
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</table>

#### Person in charge of the module
Prof. Dr. Martin Hofmann-Apitius, B-IT Center

#### Teaching unit(s) offering the module
B-IT Center, Faculty of Mathematics and Natural Sciences

#### Applicability of the module
<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>1st semester</td>
</tr>
</tbody>
</table>

#### Teaching aims
Basic knowledge in applied bioinformatics

#### Key skills qualifications
Key skills qualifications promoted by the lecture are communication, project planning and management, team work in learning groups, interpretation skills, literature management, working towards targets and on deadlines, communicating own needs, accepting constructive feedback.

#### Contents
sequence analysis, biological structures, applied bioinformatics

#### Prerequisites for participation
Enrolment to the M.Sc. programme or - for students of other programs or exchange students - admission by the Board of Examiners

#### Course elements
<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
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<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>Biological Databases</td>
<td>25</td>
<td>3</td>
<td>90</td>
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<tr>
<td>Lecture</td>
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</tbody>
</table>

#### Examinations
Type of examination: graded / not graded
Written examination: graded

#### Study elements required as prerequisite for admission to the module examination
graded / not graded

#### Additional information
# Module: Economics / Industrial Colloquium

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 135</td>
<td>120 h</td>
<td>4 SWS</td>
<td>1 semester</td>
<td>Winter semester</td>
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</table>

<table>
<thead>
<tr>
<th>Person in charge of the module</th>
<th>Dr. Karl Peter Linscheid, IMBIO</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Teaching unit(s) offering the module</th>
<th>Biology</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicability of the module</td>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching aims</th>
<th>Economics: the lecture is intended to give the students a basic understanding of (socio-)economic and legal determinants of biotechnological production. Industrial and Research Colloquium: the students learn to present their industrial or research project in front of their supervisors and students of the 1st semester.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Key skills qualifications</th>
<th>Key skills qualifications promoted by the lecture are communication, project planning and management, team work in learning groups, interpretation skills, literature management, working towards targets and on deadlines, communicating own needs, accepting constructive feedback.</th>
</tr>
</thead>
</table>

| Contents | Economics:  
- Foundations of economic theory: basics of neoclassical economics, market participants, market models, economic decisions  
- Industrial application of biotechnology: red, green and grey/white biotechnology, biotech industry worldwide  
- Patents: law and ethical issues (briefly, see course Bioethics)  
- Drug Approval  
- Company foundation: business models and businessplan, phases in company foundation and financing, stages in company development  
- Marketing;  
Industrial and Research Colloquium: The course consists of  
- attending the industrial presentations of the 3rd semester students in the 1st semester, and  
- a seminar presentation in the 3rd semester by each student about the student's practical in a research laboratory or industrial company. |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
<th>Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners</th>
</tr>
</thead>
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As of 17th November 2015
### Module: Economics / Industrial Colloquium

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tbody>
<tr>
<td>Lecture</td>
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<td>25</td>
<td>2</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Seminar</td>
<td>Industrial and Research Colloquium</td>
<td>25</td>
<td>2</td>
<td>60</td>
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<table>
<thead>
<tr>
<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics</td>
<td>Written examination</td>
<td>graded</td>
</tr>
<tr>
<td>Industrial and Research Colloquium</td>
<td>Seminar presentation</td>
<td>graded</td>
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</table>

| Study elements required as prerequisite for admission to the module examination | graded / not graded |

<table>
<thead>
<tr>
<th>Additional information</th>
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</table>
# Module: Transgenic Plants and Plant Expression Systems

<table>
<thead>
<tr>
<th>Module number MBT 201</th>
<th>Workload 150 h</th>
<th>Extent 5 SWS</th>
<th>Duration (semester) 1 semester</th>
<th>Offered Winter semester</th>
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</table>

**Person in charge of the module**
Prof. Dr. Peter Dörmann, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)

**Teaching unit(s) offering the module**
Biology

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
<td></td>
</tr>
</tbody>
</table>

**Teaching aims**
Biolistic transformation of plants (leaf discs) with reporter constructs, Agrobacterium-mediated transformation, cloning in *Escherichia coli* and *Agrobacterium tumefaciens*, screening of transgenic lines, detection of transgenes by PCR, histochemical and biochemical methods.

**Key skills qualifications**
Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

**Contents**
The practical lab exercise on plant expression systems will focus on different techniques of generating transgenic plant lines employing different model organisms including tobacco and *Arabidopsis*. Modern plant biotechnology involves different plant culture techniques and depending on the plant species and culture system, a range of transformation protocols are available. The most relevant techniques will be presented during this lab course. Laboratory techniques in modern cell biology, microscopy and visualization. Skills for documentation and presentation of scientific experiments and data.

**Prerequisites for participation**
Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

**Course elements**
<p>|</p>
<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
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**Examinations**

<table>
<thead>
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<th>Graded / not graded</th>
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<tbody>
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<td>Graded practical report</td>
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*As of 17th November 2015*
### Module: Transgenic Plants and Plant Expression Systems

<table>
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<tr>
<td>Additional information</td>
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*Teaching Unit: Biology / Master's Programme Molecular Biology and Biotechnology*

*As of 17th November 2015*
### Module: Enzyme Technology

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
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<tr>
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**Person in charge of the module**
Prof. Dr. Dorothea Bartels, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)

**Teaching unit(s) offering the module**
Biology

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

**Teaching aims**
The participants shall be enabled to estimate the stability of a protein on the basis of its amino acid sequence, biophysical data and steric structure in order to find suitable means for stabilizing its conformation in praxis, e.g. chemical (ionic strength, pH, redox potential), mechanical (inclusion immobilization), or extrinsic (modulation of the solvent). Using inhibitors as example, an understanding of possible interactions at the active center shall be developed and the participants shall gain the ability to predict unknown effectors and experimentally prove their effect. A further aspect is the choice of suitable means for long-term stabilization of enzymes (shelf life).

**Key skills qualifications**
Key skills qualifications promoted by the practical are communication, project planning and management, teamwork, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

**Contents**
Downstream processing, intrinsic and extrinsic stability of proteins, critical reactions of amino acids, stabilisation by inclusion and/or immobilisation; extrinsic stabilisation by modulators for solvents; enzyme assays in the presence of inhibitors (substrate analogs); modelling of unknown effectors.

**Prerequisites for participation**
Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners.

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tbody>
<tr>
<td></td>
<td>Wet lab practical</td>
<td>Enzymology, protein biochemistry</td>
<td>8</td>
<td>2.5</td>
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<tr>
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<td><em>in silico</em> practical</td>
<td>Protein database analysis</td>
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<td>2.5</td>
<td>75</td>
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*As of 17th November 2015*
### Module: Enzyme Technology

<table>
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<th>Examinations</th>
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| Study elements required as prerequisite for admission to the module examination | graded / not graded |
| | |

<p>| Additional information | |
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<table>
<thead>
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<td><strong>Duration (semester)</strong></td>
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<td><strong>Teaching unit(s) offering the module</strong></td>
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<tr>
<td><strong>Applicability of the module</strong></td>
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<td><strong>Programme</strong></td>
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<td><strong>Mode</strong></td>
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<tr>
<td><strong>Semester</strong></td>
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<tr>
<td><strong>Teaching aims</strong></td>
</tr>
<tr>
<td><strong>Key skills qualifications</strong></td>
</tr>
<tr>
<td><strong>Contents</strong></td>
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<tr>
<td><strong>Prerequisites for participation</strong></td>
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<tr>
<td><strong>Course elements</strong></td>
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<tr>
<td><strong>Teaching mode</strong></td>
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<tr>
<td><strong>Topic</strong></td>
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<tr>
<td><strong>Group size</strong></td>
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<td><strong>SWS</strong></td>
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<tr>
<td><strong>Examinations</strong></td>
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<td><strong>Graded practical report</strong></td>
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<td></td>
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<td><strong>Additional information</strong></td>
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*As of 17th November 2015*
# Module: Embryo Biotechnology

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
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<tbody>
<tr>
<td>MBT 206</td>
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<td>5 SWS</td>
<td>1 semester</td>
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<table>
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<tr>
<th>Person in charge of the module</th>
<th>Prof. Dr. Karl Schellander, Institut für Tierwissenschaften</th>
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<table>
<thead>
<tr>
<th>Teaching unit(s) offering the module</th>
<th>Faculty of Agriculture</th>
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<table>
<thead>
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<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd semester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching aims</th>
<th>Overview of production of transgenic animals; insight into use of transgenic animals in biological research and biotechnological application.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Key skills qualifications</th>
<th>Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Contents</th>
<th>gene transfer techniques - mammalian and bird embryos, fish, invertebrates, ES cell system, somatic gene transfer; embryo technology - handling and culture of embryos, micromanipulation, freezing technique, transfer of nuclei, microinjection; DNA integration - vector integration, expression and function; use of transgenic animals - gene function, animal models, recombinant proteins, new genetic properties</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
<th>Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners</th>
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</table>

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tbody>
<tr>
<td>Practical exercise</td>
<td>Embryo biotechnology</td>
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<table>
<thead>
<tr>
<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Graded practical report</td>
<td>graded / not graded</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Study elements required as prerequisite for admission to the module examination</th>
<th>graded / not graded</th>
</tr>
</thead>
</table>
### Module: Embryo Biotechnology

<table>
<thead>
<tr>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
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</table>

*As of 17th November 2015*
Module: Tumor Cell Biology

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
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<tbody>
<tr>
<td>MBT 207</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Summer semester</td>
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</table>

Person in charge of the module: PD Dr. Rainer Probstmeier, Klinik für Nuklearmedizin

Teaching unit(s) offering the module: Faculty of Medicine

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd semester</td>
</tr>
</tbody>
</table>

Teaching aims:
- Mammalian cell culture techniques or how to work with human tumor cell lines: You will learn how to work with human cell lines derived from brain, lung or thyroid tumors.
- Cell based assays or how to investigate the cellular behavior of tumor cells: You will learn how to manipulate and analyze the differentiation, migration, proliferation and survival capacity of tumor cells.
- Molecular analysis of tumor cells or what makes them different from their normal counterparts: You will learn how to manipulate and analyze tumor cells on the DNA, mRNA or protein level.

Key skills qualifications: Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

Contents:
- Sterile work with cell lines, techniques for nucleic acid analysis (DNA and RNA isolation, cDNA synthesis, gel electrophoresis, methylation-specific PCR, RT-PCR, etc.) and protein analysis (cell solubilisation, cell fractioning, Western blot); analysis of cell behavior (cell death, differentiation, migration, proliferation); manipulation of gene/protein expression and/or activation (drug or nucleic acid-based); indirect immunofluorescence microscopy. Remark: You should have already some practical experience with (mammalian) cell culture.

Prerequisites for participation: Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

Course elements:

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tr>
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<td>Tumor Cell Biology</td>
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As of 17th November 2015
## Module: Tumor Cell Biology

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<tr>
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<th>Type of examination</th>
<th>graded / not graded</th>
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<tbody>
<tr>
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<tr>
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<td>graded / not graded</td>
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<td>Additional information</td>
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# Module: Molecular Cell Biology

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<th>Workload 150 h</th>
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<th>Duration (semester) 1 semester</th>
<th>Offered Summer semester</th>
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<tr>
<td>Person in charge of the module</td>
<td>Prof. Dr. D. Fürst, Institut für Zellbiologie</td>
<td></td>
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<td>Teaching unit(s) offering the module</td>
<td>Biology</td>
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<td>Applicability of the module</td>
<td>Programme</td>
<td>Mode</td>
<td>Semester</td>
<td></td>
</tr>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td></td>
<td>2nd semester</td>
<td></td>
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<tr>
<td>Teaching aims</td>
<td>Analysis of protein localization, interactions and dynamics in living cells; use of high end microscopical methods</td>
<td></td>
<td></td>
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<tr>
<td>Key skills qualifications</td>
<td>Key skills qualifications promoted by the practical are project planning and management, calculation and interpretation skills, literature research, presentation, co-operative group work, communicating own needs, accepting constructive feedback, systematic analysis of problems.</td>
<td></td>
<td></td>
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<tr>
<td>Contents</td>
<td>▪ transfection and transduction of cultured cells ▪ knock-down of protein expression ▪ high resolution live cell imaging of fluorescent proteins in cells ▪ analysis of protein interactions in cells ▪ exercise-induction in cultured muscle cells</td>
<td></td>
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<tr>
<td>Prerequisites for participation</td>
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<td>SWS</td>
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<td>Practical exercise</td>
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As of 17th November 2015
# Module: Oral Surfaces

<table>
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<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
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<tbody>
<tr>
<td>MBT 209</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter or Summer semester</td>
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<table>
<thead>
<tr>
<th>Person in charge of the module</th>
<th>Teaching unit(s) offering the module</th>
<th>Applicability of the module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Dr. Matthias Frentzen, Poliklinik für Parodontologie, Zahnerhaltung und spezielle Zahnheilkunde</td>
<td>Faculty of Medicine</td>
<td></td>
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<tr>
<td></td>
<td>Molecul ar Biology and Biotechnology</td>
<td>Programme: Molecular Biology and Biotechnology Mode: Elective compulsory module</td>
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<tr>
<td></td>
<td>Elective compulsory module</td>
<td>Semester: 2nd or 3rd semester</td>
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</table>

## Teaching aims
The students acquire theoretical and practical knowledge and skills for evaluation of oral biofilms and foundations of interventional methods for modulation of biofilms.

## Key skills qualifications
Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

## Contents

## Prerequisites for participation
Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

## Course elements
<table>
<thead>
<tr>
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## Examinations
Type of examination: graded / not graded

## Study elements required as prerequisite for admission to the module examination
Type of examination: graded / not graded

## Additional information

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As of 17th November 2015
# Module: Cultivation Techniques for Fungi

<table>
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<th>Extent</th>
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<th>Offered</th>
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<td>Summer semester</td>
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<table>
<thead>
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<th>Person in charge of the module</th>
<th>Dr. Jürgen Lenz, Senzyme GmbH</th>
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<table>
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## Applicability of the module

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<th>Mode</th>
<th>Semester</th>
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<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd semester</td>
</tr>
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</table>

## Teaching aims

Independent analysis of differences between cultivation techniques for fungi, yeasts, and bacteria; overview of the applications of filamentous fungi in biotechnology.

## Key skills qualifications

Key skills qualifications promoted by the practical are communication, project planning and management, teamwork, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

## Contents

- Solid state fermentation, submerged fermentation, hydrolases / oxidases / peroxidases, filamentous fungi as expression systems, production of food additives (aromas, pigments), production of enzymes (cellulase, laccase), production of secondary metabolites (antibiotics), heterologous expression in filamentous fungi, methods from bioprocess engineering, molecular genetics, protein biochemistry, analytics.

## Prerequisites for participation

Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners.

## Course elements

<table>
<thead>
<tr>
<th>Teaching mode</th>
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<th>Workload [h]</th>
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## Examinations

Type of examination: graded / not graded

- Practical report: graded

## Additional information

As of 17th November 2015
Module: Drugs from Plants and Microorganisms

<table>
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<td>1 semester</td>
<td>Winter semester</td>
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</table>

Person in charge of the module
Prof. Dr. Gabriele König, Institut für Pharmazeutische Biologie

Teaching unit(s) offering the module
Faculty of Mathematics and Natural Sciences

Applicability of the module
<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

Teaching aims
The students get an overview of structures and biosynthesis of natural products, the course provides knowledge of molecular biological analysis and identification of biosynthesis genes, enzymes and proteins.

Key skills qualifications
Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

Contents
Biosynthesis and analysis of physiologically active natural products: isolation and chemical analysis of natural products (HPLC, TLC, GC, NMR); biosynthesis of antibiotics, detection of genes for biosynthetic pathways, recombinant drugs, production and mode of action of chemotherapeutics.

Prerequisites for participation
Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

Course elements
<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
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<tbody>
<tr>
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Examinations
Type of examination
graded / not graded

Practical report
graded

Study elements required as prerequisite for admission to the module examination
graded / not graded

Additional information
## Module: Proteomics

<table>
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<th>Extent</th>
<th>Duration</th>
<th>Offered</th>
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<td>5 SWS</td>
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### Person in charge of the module

### Teaching unit(s) offering the module

### Applicability of the module

<table>
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<tr>
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<th>Mode</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

### Teaching aims

Students learn to identify, isolate and characterise proteins from tissues of molecugenuetically well defined model organisms.

### Key skills qualifications

Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

### Contents

Protein isolation and characterisation using mass spectrometry. Analysis of post-translational protein modifications.

### Prerequisites for participation

Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners.

### Course elements

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
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<th>Workload [h]</th>
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<tr>
<td>Practical exercise</td>
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### Examinations

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### Study elements required as prerequisite for admission to the module examination

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<tbody>
<tr>
<td>Practical report</td>
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### Additional information

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As of 17th November 2015
# Module: Extremophilic Bacteria

<table>
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<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
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<tbody>
<tr>
<td>MBT 214</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter semester</td>
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</table>

| Person in charge of the module | Prof. Dr. E. Galinski, Institut für Mikrobiologie und Biotechnologie |

| Teaching unit(s) offering the module | Biology |

### Applicability of the module

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

| Teaching aims and contents | Students will adopt well-known fermentation techniques to the special requirements of "extremophilic" bacteria. This course will also teach the ability to recover and purify low-molecular weight natural compounds (compatible solutes) from such organisms. In addition, the extremely halotolerant bacterium *Halomonas elongata* will be employed as an alternative expression system. |

### Key skills qualifications

Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

### Prerequisites for participation

Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners, successful participation in the compulsory practical "Biotechnology 1" (MBT 117)

### Course elements

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<tr>
<td>Practical exercise</td>
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### Examinations

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### Study elements required as prerequisite for admission to the module examination

<table>
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### Additional information

As of 17th November 2015
# Module: Preventive, Predictive and Personalized Medicine

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<th>Extent</th>
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<th>Offered</th>
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<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter semester</td>
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**Person in charge of the module**

Prof. Dr. Olga Golubnitschaja, Radiologische Klinik

**Teaching unit(s) offering the module**

Faculty of Medicine

### Applicability of the module

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

### Teaching aims

- Metabolic pathways affected in pathomechanisms of cardiovascular complications secondary to Diabetes mellitus type II,
- metabolic pathways affected in pathomechanisms of neurodegenerative diseases,
- metabolic pathways affected in pathomechanisms of selected tumors, using the examples of glioblastoma and breast cancer,
- stress and repair mechanisms (comet assay technology),
- role and evaluation of tissue remodelling-protein complexes (technology of zymography),
- pathology specific expression patterns (technologies of clinical proteomics and real-time PCR),
- analysis of disease-specific expression arrays,
- written summary of the experimental design and results, presentation of a research hypothesis.

### Key skills qualifications

Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

### Contents

- Significance of early or preventative diagnostics in cardiovascular and tumor diseases,
- application of modern biotechnologies in medical diagnostics,
- introduction into molecular and minimally invasive diagnostic technologies,
- development of pathology-specific biomarkers.

### Prerequisites for participation

Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

*As of 17th November 2015*
# Module: Preventive, Predictive and Personalized Medicine

<table>
<thead>
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<th>Teaching mode</th>
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<th>Group size</th>
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## Examinations
- Type of examination: graded / not graded
- Practical report: graded
- Practical report: graded / not graded

## Study elements required as prerequisite for admission to the module examination

## Additional information

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As of 17th November 2015
## Module: Biosynthesis of Natural Products

<table>
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<th>Workload</th>
<th>Extent</th>
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<tr>
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<tbody>
<tr>
<td>Prof. Dr. Gabriele König, Institut für Pharmazeutische Biologie</td>
<td>Faculty of Mathematics and Natural Sciences</td>
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### Module number and details

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<th>Semester</th>
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<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
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</table>

### Teaching aims

The students get an overview of structures and biosynthesis of natural products, the course provides knowledge of molecular biological analysis and identification of biosynthesis genes, enzymes and proteins.

### Key skills qualifications

Key skills qualifications promoted by the practical are communication, project planning and management, teamwork, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control.

### Contents

Overview of the structure and biosynthesis of natural products, analysis and identification of genes for biosynthetic pathways, enzymes and proteins using molecular methods (PCR, electrophoresis, blotting techniques).

### Prerequisites for participation

Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners.

### Course elements

<table>
<thead>
<tr>
<th>Teaching mode</th>
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<th>SWS</th>
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### Examinations

Type of examination: graded / not graded

Practical report: graded

### Study elements required as prerequisite for admission to the module examination

Graded / not graded

### Additional information

As of 17th November 2015
## Module: Cell Mechanics

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</tbody>
</table>

| Teaching aims | Animal cells are continuously in contact with their environment and able to send as well as receive signals. In addition to chemical signals, mechanical signals play a pivotal role by regulating a plethora of essential cellular functions like embryogenesis, cell migration, adhesion, formation of multicellular structures, morphology, and differentiation. The aim of this module is to exactly analyze the diverse mechanical signals within animal organisms in order to elucidate the functioning of widespread mechanosensitive processes. This concept will help to understand that in experimental setups, which are designed close to the *in vivo* situation, a combination of chemical and mechanical signals must be used. To characterize cellular mechanics, cellular forces required for the function of each individual cell in processes of adhesion and migration, are analyzed. In addition to the mechanical forces induced by the cell itself, animal cells also react to mechanical signals from the surrounding tissue. These signals may induce minor adaptations as well as major processes of cellular differentiation or vectored migration and are more closely investigated through the parameters substrate elasticity, topography, and environmental stretch. Since virtually every mechanical event has an impact on cell viscosity and elasticity, the evaluation of these parameters completes the analysis of cellular mechanics. |

| Key skills qualifications | Key skills qualifications promoted by the practical are communication, project planning and management, team work, calculation and interpretation skills, literature research, data reduction, text processing, presentation, co-operative group work, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control. |

<table>
<thead>
<tr>
<th>Contents</th>
<th>Mechanical functions of the cell: live cell imaging and immunocytochemistry, substrate deformation and cellular force analysis of animal cells under various conditions and at different stages of cellular differentiation;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mechanical properties of the cell: atomic force microscopy (AFM) to measure the elasticity of cells under various conditions and at different stages of differentiation, high-resolution visualization of cytoskeletal structures, analysis of the influence of selective mechanical stimuli on the induction of cellular reactions, analysis of</td>
</tr>
</tbody>
</table>

*As of 17th November 2015*
### Module: Cell Mechanics

- cellular viscoelasticity in the context of molecular mobility;
  - Mechanical signals recognized by the cell: evaluation of parameters to control cellular behavior and differentiation – substrate stiffness, substrate stretch, topography – including morphological and functional tests.

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
<th>Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course elements</td>
<td></td>
</tr>
<tr>
<td><strong>Teaching mode</strong></td>
<td></td>
</tr>
<tr>
<td>Practical exercise</td>
<td>Cell Mechanics</td>
</tr>
<tr>
<td>Group size</td>
<td>12</td>
</tr>
<tr>
<td>SWS</td>
<td>5</td>
</tr>
<tr>
<td>Workload [h]</td>
<td>150</td>
</tr>
<tr>
<td>Examinations</td>
<td>Type of examination</td>
</tr>
<tr>
<td>Practical report</td>
<td>graded / not graded</td>
</tr>
<tr>
<td>Study elements required as prerequisite for admission to the module examination</td>
<td>graded / not graded</td>
</tr>
<tr>
<td>Additional information</td>
<td></td>
</tr>
</tbody>
</table>
## Module: Biochemical Engineering

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 222</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Summer semester</td>
</tr>
</tbody>
</table>

### Person in charge of the module
Prof. Dr. Marco Oldiges

### Teaching unit(s) offering the module
Jülich Research Centre

### Applicability of the module

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd semester</td>
</tr>
</tbody>
</table>

### Teaching aims
The basic principles and main aspects of biochemical engineering are introduced. The opportunities and limitations of procedures available for each process step shall be recognized as a prerequisite for planning and establishing biotechnological process development.

### Key skills qualifications
Key skills qualifications promoted by the lecture are communication, project planning and management, team work in learning groups, interpretation skills, literature management, working towards targets and on deadlines, communicating own needs, accepting constructive feedback.

### Contents
Biochemical Engineering: After brief introduction in general aspects of biochemical engineering, the topics relevant for cultivation and application of microbial cells are in the main focus: i.e. sterilisation, bioreactors (types and function of relevant components), mass transfer (e.g. O₂, CO₂), mixing, bioprocess strategy (batch, fed-batch, continuous), process analytical technology, downstream processing of products. In addition successful examples of metabolic and bioprocess engineering studies for small molecules production are introduced.

Biotransformation: Basic principles of biocatalysis, production of fine chemicals, purification and application of biocatalysts, comparison enzyme vs. whole cell biotransformation, industrial processes (food, detergents, pharmaceutical precursor, fine chemicals, scale up (from lab to production scale), downstream processing.

### Prerequisites for participation
Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

### Course elements

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical exercise</td>
<td>Biochemical Engineering</td>
<td>Individual registration</td>
<td>3</td>
<td>150</td>
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</tbody>
</table>

### Examinations

<table>
<thead>
<tr>
<th>Type of examination</th>
<th>Graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical report</td>
<td>graded</td>
</tr>
</tbody>
</table>

As of 17th November 2015
### Module: Biochemical Engineering

<table>
<thead>
<tr>
<th>Study elements required as prerequisite for admission to the module examination</th>
<th>graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional information</td>
<td></td>
</tr>
</tbody>
</table>

As of 17th November 2015
# Module: Fluorescent Protein-based Biosensors

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 223</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Summer semester</td>
</tr>
</tbody>
</table>

**Person in charge of the module**
Prof. Dr. Andreas Meyer, Institut für Nutzpflanzenwissenschaft und Ressourcenschutz (INRES) – Chemical Signalling

**Teaching unit(s) offering the module**
Faculty of Agriculture

**Module number**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd semester</td>
</tr>
</tbody>
</table>

**Teaching aims**
Generation and validation of genetically encoded biosensors; application of GFP-based probes for dynamic in vivo measurements of physiological parameters and for the analysis of membrane proteins

**Key skills qualifications**
Key skills qualifications promoted by the practical are formulation of working hypotheses, experimental design and planning, calculation and interpretation of results, presentation of results in oral and text form

**Contents**
Expression of recombinant proteins in *E. coli*; spectral characterization of purified fluorescent proteins; selection of transgenic plants; ratiometric laser scanning microscopy; image analysis; Gateway cloning; transient expression of membrane proteins tagged with GFP-based biosensors in tobacco; membrane isolation and protein protection assays

**Prerequisites for participation**
Enrolment to the M.Sc. programme or - for students of other programmes or exchange students - admission by the Board of Examiners

**Course elements**

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical exercise</td>
<td>Biosensors</td>
<td>4</td>
<td>3</td>
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</table>

**Examinations**

<table>
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<th>Type of examination</th>
<th>graded / not graded</th>
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</thead>
<tbody>
<tr>
<td>Practical report</td>
<td>graded</td>
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</tbody>
</table>

**Study elements required as prerequisite for admission to the module examination**

<table>
<thead>
<tr>
<th>type of examination</th>
<th>graded / not graded</th>
</tr>
</thead>
</table>

**Additional information**

As of 20th December 2015
Module: Molecular Haematology  
(From patient to phenotype: characterization of blood coagulation disorders)

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 224</td>
<td>300 h</td>
<td>10 SWS</td>
<td>1 semester</td>
<td>3rd semester (Winter)</td>
</tr>
</tbody>
</table>

Person in charge of the module
Prof. Dr. Johannes Oldenburg  
Institute for Experimental Haematology and Transfusion Medicine (IHT)

Teaching unit offering the module
Faculty of Medicine, Institute for Experimental Haematology and Transfusion Medicine (IHT)

Applicability of the module
<table>
<thead>
<tr>
<th>Program</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
</tr>
</tbody>
</table>

Teaching aims
The aim of this module is to identify and further characterize patient’s phenotype by different methods. The students will learn how to plan a project and develop several strategies to investigate specific mutations on DNA and protein level. The course provides knowledge about current techniques used in molecular biology including DNA analysis, cell culture, cell-based assays and in silico modelling.

Key skills qualifications
Key skills qualifications promoted by the practical course are project design and management, systematic analysis of problems, data analysis and presentation, team work, cooperative group work and literature search.

Contents:
- Identification of patients coagulation disorders:
  a. Coagulation assays (e.g. whole blood and plasma-based global coagulation assays, detection of coagulation factor inhibiting antibodies)
  b. DNA preparation from blood, PCR, Sanger sequencing and analysis
- Investigation of the identified mutation by several strategies in order to characterize the phenotype:
  a. Cloning of target cDNA into a vector by restriction-free cloning PCR, mutagenesis PCR, transfection and expression in mammalian cell line and genetically modified cell lines (CRISPR/Cas9), analysis of the mutant protein by coagulation based assays (e.g. ELISA)
  b. Reprogramming of patient and WT blood in induced pluripotent stem (IPS) cells, characterization of IPS cells (intracellular staining of pluripotency markers, embryoid body formation), cultivation of IPS cells (Clump splitting), differentiation into endothelial cells
  c. Protein modelling of wild-type and mutated protein
| Module: Molecular Haematology  
(From patient to phenotype: characterization of blood coagulation disorders) |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Module number MBT 224</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Prerequisites for participation</td>
</tr>
<tr>
<td>Course elements</td>
</tr>
<tr>
<td>Practical exercise</td>
</tr>
<tr>
<td>Examinations</td>
</tr>
<tr>
<td>Practical report</td>
</tr>
<tr>
<td>Study elements required as prerequisite for admission to the module examination</td>
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<tr>
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<tr>
<td>Additional information</td>
</tr>
</tbody>
</table>

20.10.2016
# Module: Laboratory Practical 1

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 297</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter or Summer semester</td>
</tr>
</tbody>
</table>

| Person in charge of the module | Dr. Karl Peter Linscheid, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO) |
| Teaching unit(s) offering the module | Institutes and departments of the teaching staff to the M.Sc. programme |

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd or 3rd semester</td>
<td></td>
</tr>
</tbody>
</table>

**Teaching aims**
Guided experimental work in the laboratory

**Key skills qualifications**
Key skills qualifications promoted by the practical are communication, project planning and management, calculation and interpretation skills, literature research, data reduction, text processing, presentation, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control, for project work at the Research Center of Juelich or external projects: managing off-campus accommodation.

**Contents**
The students work in a laboratory environment in the scientific groups of the departments involved in the study program.

**Prerequisites for participation**

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical exercise</td>
<td>Free laboratory practical (lab rotation)</td>
<td>Individual registration</td>
<td>3</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project report</td>
<td></td>
<td>graded</td>
</tr>
</tbody>
</table>

| Study elements required as prerequisite for admission to the module examination | graded / not graded |
| Additional information |诅咒了直接 |
### Module: Laboratory Practical 2

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 298</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter or Summer semester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Person in charge of the module</th>
<th>Dr. Karl Peter Linscheid, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Teaching unit(s) offering the module</th>
<th>Institutes and departments of the teaching staff to the M.Sc. programme</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2\textsuperscript{nd} or 3\textsuperscript{rd} semester</td>
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</table>

<table>
<thead>
<tr>
<th>Teaching aims</th>
<th>Guided experimental work in the laboratory</th>
</tr>
</thead>
</table>

| Key skills qualifications | Key skills qualifications promoted by the practical are communication, project planning and management, calculation and interpretation skills, literature research, data reduction, text processing, presentation, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control, for project work at the Research Center of Juelich or external projects: managing off-campus accommodation. |

<table>
<thead>
<tr>
<th>Contents</th>
<th>The students work in a laboratory environment in the scientific groups of the departments involved in the study program.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Course elements</th>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical exercise</td>
<td>Free laboratory practical (lab rotation)</td>
<td>Individual registration</td>
<td>3</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project report</td>
<td></td>
<td>graded</td>
</tr>
</tbody>
</table>

| Study elements required as prerequisite for admission to the module examination | graded / not graded |
| Additional information | |
### Module: Laboratory Practical 3

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 299</td>
<td>150 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter or Summer semester</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Person in charge of the module</th>
<th>Dr. Karl Peter Linscheid, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching unit(s) offering the module</td>
<td>Institutes and departments of the teaching staff to the M.Sc. programme</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>2nd or 3rd semester</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Teaching aims</th>
<th>Guided experimental work in the laboratory</th>
</tr>
</thead>
</table>

| Key skills qualifications | Key skills qualifications promoted by the practical are communication, project planning and management, calculation and interpretation skills, literature research, data reduction, text processing, presentation, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control, for project work at the Research Center of Juelich or external projects: managing off-campus accommodation. |

| Contents | The students work in a laboratory environment in the scientific groups of the departments involved in the study program. |

<table>
<thead>
<tr>
<th>Prerequisites for participation</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Course elements</th>
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<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical exercise</td>
<td>Free laboratory practical (lab rotation)</td>
<td>Individual registration</td>
<td>3</td>
<td>150</td>
<td></td>
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<table>
<thead>
<tr>
<th>Examinations</th>
<th>Type of examination</th>
<th>graded / not graded</th>
</tr>
</thead>
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<td>Project report</td>
<td>graded</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study elements required as prerequisite for admission to the module examination</th>
<th>graded / not graded</th>
</tr>
</thead>
</table>

| Additional information | This practical needs to be combined with a regular practical course |

As of 20th December 2016
### Module: Project Work

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 300</td>
<td>180 h</td>
<td>5 SWS</td>
<td>1 semester</td>
<td>Winter semester</td>
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**Person in charge of the module**
Dr. Karl Peter Linscheid, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO)

**Teaching unit(s) offering the module**
Institutes and departments of the teaching staff to the M.Sc. program

**Applicability of the module**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Elective compulsory module</td>
<td>3rd semester</td>
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</tbody>
</table>

**Teaching aims**
Independent experimental work in the laboratory

**Key skills qualifications**
Key skills qualifications promoted by the thesis work are communication, project planning and management, calculation and interpretation skills, literature research, data reduction, text processing, presentation, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control, for project work at the Research Center of Juelich or external projects: managing off-campus accommodation.

**Contents**
The students work in a laboratory environment in the scientific groups of the departments involved in the study program.

**Prerequisites for participation**
Minimum 60 credit points from previous examinations

**Course elements**

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
<th>Workload [h]</th>
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<tbody>
<tr>
<td>Project</td>
<td>Project work</td>
<td>Individual project</td>
<td>4</td>
<td>180 h</td>
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**Examinations**

<table>
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<th>Type of examination</th>
<th>graded / not graded</th>
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</thead>
<tbody>
<tr>
<td>Project report</td>
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</tbody>
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**Study elements required as prerequisite for admission to the module examination**

**Additional information**

*As of 17th November 2015*
Module: Master Thesis

<table>
<thead>
<tr>
<th>Module number</th>
<th>Workload</th>
<th>Extent</th>
<th>Duration (semester)</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT 400</td>
<td>900 h</td>
<td>1 semester</td>
<td>Summer semester</td>
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</table>

Person in charge of the module
The chairman of the Board of Examiners Prof. Dr. M. Frentzen, contact Dr. K.P. Linscheid (Course Coordinator)

Teaching unit(s) offering the module
Institutes and departments of the teaching staff to the M.Sc. programme

<table>
<thead>
<tr>
<th>Applicability of the module</th>
<th>Programme</th>
<th>Mode</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Biology and Biotechnology</td>
<td>Compulsory module</td>
<td>4th semester</td>
<td></td>
</tr>
</tbody>
</table>

Teaching aims
The previously acquired knowledge and skills are to be practically applied in the context of a well-defined scientific problem

Key skills qualifications
Key skills qualifications promoted by the thesis work are communication, project planning and management, calculation and interpretation skills, literature research, data reduction, text processing, presentation, working towards targets and on deadlines, communicating own needs, accepting constructive feedback, systematic analysis of problems, process design and control, for project work at the Research Center of Juelich or external projects: managing off-campus accommodation.

Contents
The Master Thesis is the final part of the studies. The students work in a laboratory environment in the scientific groups of the departments involved in the study program. Their work usually contributes to a project leading to a scientific publication. Towards the end of the semester, the students present their results in a seminar.

Prerequisites for participation
Minimum 78 credit points from previous examinations, registration of the project and approval by the Chairman of the Board of Examiners, Master Seminar presentation.

Course elements

<table>
<thead>
<tr>
<th>Teaching mode</th>
<th>Topic</th>
<th>Group size</th>
<th>SWS</th>
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Examinations
Type of examination
Graduation dissertation

Examinations
Graded / not graded

Graded

As of 17th November 2015
### Module: Master Thesis

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