Modulhandbuch
M.Sc. Synthetic Biology

Inhalt

Modulhandbuch
M.Sc. Synthetic Biology

Compulsory Area

Module Description

Module name Basics in Synthetic Biology					
Module no. 10-42-0001	**Credit Points** 15 CP	**Workload** 450 h	**Self-study** 190 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Prof. Dr. Dominik Niopek		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-42-0001-pr	Basics in Synthetic Biology - Practical Course	8	Practical / Lab / Internship	12
10-42-0001-se	Basics in Synthetic Biology - Seminar	2	Seminar	2
10-42-0001-vl	Basics in Synthetic Biology - Lecture	2	Lecture	2
18-kp-3010-vl	Mathematical foundations of modeling & analysis	3	Lecture	2

2 Study Content

Basics in Synthetic Biology - Lecture:
Introduction to Synthetic Biology and presentation of the current state of the research field. The lecture also introduces research methods of relevance for Synthetic Biology. Specific topics are, for instance:
- Chassis/model organisms in Synthetic Biology
- Orthogonality and modularity of biological parts
- Top down and bottom up strategies in Synthetic Biology; Minimal cells, synthetic cells
- DNA engineering: molecular cloning, CRISPR genome editing, gene/genome synthesis, genetic circuits
- RNA engineering: Selex, aptamers and riboswitches
- Protein engineering: protein folding theory, protein engineering strategies, methods of protein production and purification
- Optogenetics
- Methods for directed evolution
- Screening technologies
- DNA/RNA sequencing
- Metabolic engineering
- Databases
- Machine learning models in the context of Synthetic Biology

Basics in Synthetic Biology - Seminar:
- Presentation and discussion of recent publications in the field of Synthetic Biology
- Presentation and discussion of the experimental results from the related practical course
- Literature research and project planning related to the practical course

Basics in Synthetic Biology - Practical course:

	Students are taught a wide range of Synthetic Biology methods. Examples are: - Cloning methods: Gibson assembly, Golden Gate assembly, restriction cloning -- DNA, RNA, and protein purification -- Measurement of DNA, RNA, protein concentration -- Cultivation of E. coli, yeast and mammalian cells -- CRISPR genome editing -- DNA/RNA sequencing -- Control of gene expression using riboswitches -- Optogenetic protein regulation -- Flow cytometry, fluorescence microscopy, plate reader assays -- Database search -- Data analysis The experiments carried out in the practical course will be documented in a laboratory notebook. Results from these experiments will be presented and discussed during the accompanying seminar. Mathematical foundations of modeling & analysis The module provides the basic mathematical background for computational modeling and analysis in the context of synthetic biology. Basic mathematical concepts are reviewed to provide a common ground to all students. •Fundamentals of vector calculus and linear algebra •Fundamentals of multivariate optimization •Fundamentals of deterministic dynamical systems •Fundamentals of probability theory and multivariate statistics •Fundamentals of stochastic dynamical systems •Application of concepts in the modeling and analysis case studies
3	**Learning Outcomes** Following completion of the module, students will be capable of: •Independently applying molecular biological and cell biological methods in the context of Synthetic Biology •Understanding and researching (primary) literature in the field •Analyzing, presenting and interpreting different types of experimental data •Writing a laboratory notebook for experimental documentation •Catagorizing modeling and analysis approaches according to the used mathematics and find dedicated literature for an in-depth coverage •Applying the acquired mathematics in order to understand in their own novel modeling and analysis methods •mathematically formalizing practical modeling problems encountered in the domain of synthetic biology
4	**Requirements for Participation** none
5	**Form of Examination** Course Examination: • [10-42-0001-pr] (Study Examination, Laboratory Notebook, Standard) • [18-kp-3010-vl] (Technical Examination, Written Exam, Duration 60 min, Standard)

	• [10-42-0001-vl] (Technical Examination, Written Exam, Duration 60 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exams. Compulsory attendance in 75% of the practical course. Acquisition and development of laboratory skills depends on working in the laboratory during the practical course.
7	**Grading** Course Examination: • [10-42-0001-pr] (Study Examination, Laboratory Notebook, Weight: 50%, Standard) • [18-kp-3010-vl] (Technical Examination, Written Exam, Weight: 25%, Standard) • [10-42-0001-vl] (Technical Examination, Written Exam, Weight: 25%, Standard)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature** Christina Smolke: Synthetic Biology: Parts, Devices and Applications, WILEY-VCH Vikram Singh & Pawan K. Dhar: Systems and Synthetic Biology, Springer
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name
Intercultural Skills and Project Management</td></tr>
<tr><td>Module no.
10-42-0002</td><td>Credit Points
5 CP</td><td>Workload
150 h</td><td>Self-study
110 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
PD Dr. Ulrike Homann</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0002-pj</td><td>Intercultural Skills and Project Management - Project Seminar</td><td>5</td><td>Project</td><td>4</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Basic topics of Synthetic Biology will be worked out in small student teams. Beside the scientific focus, it contains significant skills-oriented elements such as intercultural team building, project management, and presentations training (posters and oral presentations). The results of the teamwork are presented in the seminar. Presentation of the results may include both, talks and posters.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
Following completion of the module, students will be able to:
•name basic concepts of project management
•reflect on their own and other intercultural backgrounds and team processes
•evaluated synthetic biology topics with respect to globalization and ethical standards
•describe and present the results of their work in a scientifically adequate form.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:
• Module Examination (Study Examination, Portfolio, Passed / Not Passed)</td></tr>
<tr><td>6</td><td colspan="6">Requirements on the Award of Credit Points
Passing the exams. Compulsory attendance in 75% of the seminar. A focus of the module is on solving a problem in a team. For this purpose, it is necessary that the team members spend time together as a team. Furthermore, acquisition and development of intercultural and team competence depends on interaction with the team during the seminar.</td></tr>
<tr><td>7</td><td colspan="6">Grading
Final Module Examination:</td></tr>
</table>

	• Module Examination (Study Examination, Portfolio, Weight: 100%, Passed / Not Passed)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature**
10	**Comment**

Module Description

Module name Current Synthetic Biology					
Module no. 10-42-0003	**Credit Points** 5 CP	**Workload** 150 h	**Self-study** 125 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Prof. Dr. Torsten Waldminghaus		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-42-0003-se	Current Synthetic Biology - Seminar	2	Seminar	2
10-42-0003-vl	Current Synthetic Biology - Lecture	3	Lecture	2

2 Study Content

Lecture:
The lecture gives an in-depth insight into modern methods and concepts of synthetic biology with emphasis on interdisciplinary work. Current developments within the field of synthetic biology will be highlighted and key examples of research are presented in detail. A special focus is on the synthetic biology research currently ongoing at the TUDa and connected institutions.
Seminar:
Within the seminar, students will build on the teaching content of the lecture covering all presented topics to prepare a scientific talk on one aspect in great depth. Seminar topics will thereby extent the knowledge acquired within the lecture focusing on concrete examples, potentially including the planning of possible future follow up experiments or research directions. The results of the work will be within the seminar as oral presentation.

3 Learning Outcomes

The students will be able
- to gain a basic understanding of current concepts and methods of synthetic biology
- to read research publications and to critically evaluate published research data
- discuss a scientific topic in the global context of the field (review of recently published literature) with supervisors in a comprehensive and competent manner
- present a research topic to fellow students and supervisors

4 Requirements for Participation

none

5 Form of Examination

Final Module Examination:

	• Module Examination (Technical Examination, Presentation, Standard)
6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, Presentation, Weight: 100%, Standard)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature** Kuldell, Hart, Bernstein, Ingram (2015), BioBuilder: Synthetic Biology in the Lab, O'Reilly
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Science Communication and Bioethics/Biosecurity</td></tr>
<tr><td>Module no.
10-42-0004</td><td>Credit Points
6 CP</td><td>Workload
180 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. Andreas Jürgens</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>02-25-2901-se</td><td>Science Communication</td><td>3</td><td>Seminar</td><td>3</td></tr>
<tr><td>10-42-0004-se</td><td>Bioethics and Biosecurity</td><td>3</td><td>Seminar</td><td>3</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
“Biosecurity cannot be achieved unless scientists themselves are recognized as an essential part of the solution and are engaged in all discussions around the issue.” [Revill et al. 2012]
Science Communication
The course Science Communication addresses aspects of communicating scientific knowledge to the broader public or to specific stakeholders and serves both reflection and orientation. The reflection part deals with aspects such as scientific identity, comprehensibility and responsibility as well as factors of public trust in science in the context of mediatization and politicization of science. The application part focuses on media, formats and text types, and on possible critical interaction situations in dealing with journalists and mediation strategies.

Bioethics and biosecurity
The course integrates biosecurity and bioethics with the broader topic of research safety and security measures. Overarching concepts such as risk assessment and management, along with general safety legislation requirements, are discussed. Attention then moves to areas of concern, such as the research use of infectious/toxic biological materials, concepts such as dual use of science.
In the seminar students will learn, using examples, how to critically analyse topics related to biosafety/biosecurity. As a preparation for this exercise current bioethics and biosecurity issues will be discussed in groups. Students will gain the skills to seek out and analyse information related to biosecurity and then discuss public policies, and strategies for enhancing biosecurity.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After completion of this module students will be able to,
•impart pragmatic contextual knowledge
•get a reflective competence with regard to external science communication
•use first concrete writing experiences
•consider how bioethical dilemmas are shaped by life sciences professionals’</td></tr>
</table>

	•understand the cultural values and beliefs about the concepts of biosafety, biosecurity, and responsible conduct of research. write and verbalise scientific information in an accurate, interesting, logical and coherent manner •analyse potential challenges and dilemmas associated with their work, including weighing potential risks and benefits, dual use concerns, and the possibility of accidents or misuse of life sciences research
4	**Requirements for Participation** none
5	**Form of Examination** Final Module Examination: • Module Examination (Study Examination, Essay, Passed / Not Passed)
6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Essay, Weight: 100%, Passed / Not Passed)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature** Revill J., M.D.C. Carnevali, Å. Forsberg, A. Holmström, J. Rath, Z.Khan Shinwari, G.M. Mancini. Lessons learned from implementing education on dual-use in Austria, Italy, Pakistan and Sweden. Medicine, Conflict and Survival, 28 (1) Preventing the Hostile Use of the Life Sciences and Biotechnologies: Fostering a Culture of Biosecurity and Dual Use Awareness, pp. 31-44. More: To be announced.
10	**Comment**

Module Description

Module name DNA-focused Synthetic Biology					
Module no. 10-42-0005	**Credit Points** 6 CP	**Workload** 180 h	**Self-study** 90 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Prof. Dr. Torsten Waldminghaus		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-42-0005-pr	DNA-focused Synthetic Biology - Practical Course	4	Practical / Lab / Internship	5
10-42-0005-se	DNA-focused Synthetic Biology - Seminar	1	Seminar	1
10-42-0005-vl	DNA-focused Synthetic Biology - Lecture	1	Lecture	1

2 Study Content

Lecture:
The lecture covers a brought range of topics related to DNA-focused Synthetic Biology. This includes key methodologies as multifragment-cloning techniques, hierarchical cloning techniques, genome engineering, DNA synthesis, next generation sequencing, bioinformatic sequence analysis and DNA origami. In addition, main concepts as Replicon-Design, Genetic Context, Genome Stability, Synthetic Genomics, Xeno Nucleic Acids, Neo-Chromosomes, DNA Modifications and DNA origami will be covered.
Seminar:
Recent scientific publications in the field of DNA-focused Synthetic Biology will be used to prepare oral presentations to be shared with all students attending the course. In addition, the experimental results of the lab course will be presented as oral presentation and discussed.
Lab course:
Research projects will be developed in groups and pursued over the duration of the course. The projects are related to topics and methods of DNA-focused Synthetic Biology e.g. the following:
- Design of prokaryotic and eukaryotic replicons
- Modular Cloning (MoClo)
- Gibson Assembly
- Ligase Chain Reaction
- DNA Origami
- Large Scale Genome Rearrangements
- Digital PCR
- Genetic Context
- DNA Modifications
- Neo-Chromosomes

	•Bioinformatics of DNA sequences
3	**Learning Outcomes** The students will be able •to gain a solid understanding of concepts and methods of DNA-focused synthetic biology •to discuss the project work in the global context of the field (review of recently published literature) with supervisors and students •to present a research topic to fellow students and supervisors •to collect, interpret, and evaluate data obtained through application of synthetic biology methods •to work as a team on a joint scientific project
4	**Requirements for Participation** Passing of module “Basics in Synthetic Biology”
5	**Form of Examination** Course Examination: • [10-42-0005-vl] (Technical Examination, Written Exam, Duration 60 min, Standard) • [10-42-0005-pr] (Study Examination, Laboratory Notebook, Standard)
6	**Requirements on the Award of Credit Points** Passing the exams. Compulsory attendance in 75% of the practical course. Acquisition and development of laboratory skills depends on working in the laboratory during the practical course.
7	**Grading** Course Examination: • [10-42-0005-vl] (Technical Examination, Written Exam, Weight: 50%, Standard) • [10-42-0005-pr] (Study Examination, Laboratory Notebook, Weight: 50%, Standard)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature** Kuldell, Hart, Bernstein, Ingram (2015), BioBuilder: Synthetic Biology in the Lab, O'Reilly
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name
RNA Synthetic Biology</td></tr>
<tr><td>Module no.
10-42-0006</td><td>Credit Points
6 CP</td><td>Workload
180 h</td><td>Self-study
90 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. Beatrix Süß</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0006-pr</td><td>RNA Synthetic Biology - Practical Course</td><td>4</td><td>Practical / Lab / Internship</td><td>5</td></tr>
<tr><td>10-42-0006-se</td><td>RNA Synthetic Biology - Seminar</td><td>1</td><td>Seminar</td><td>1</td></tr>
<tr><td>10-42-0006-vl</td><td>RNA Synthetic Biology - Lecture</td><td>1</td><td>Lecture</td><td>1</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Lecture:
The lecture covers a brought range of topics related to RNA Synthetic Biology. This includes basics in RNA structure and structure determination, concepts of RNA regulation, synthetic riboswitches, synthetic cis acting regulatory RNA, aptazymes, RNA-based logic gates and genetic circuits design, RNA aptamer development and application, RNA-based biosensors, RNA origami and RNA modification.
Seminar:
Recent scientific publications in the field of RNA Synthetic Biology will be used to prepare oral presentations to be shared with all students attending the course. In addition, the experimental results of the lab course will be presented as oral presentation and discussed.
Lab course:
Research projects will be developed in groups and pursued over the duration of the course. The projects are related to topics and methods of RNA Synthetic Biology e.g. the following:
•RNA secondary structure prediction
•Aptamer selection
•Design of synthetic riboswitches and cis acting regulatory RNAs
•Design of RNA logic gates and genetic circuits
•Design of RNA-based biosensors
•RNA Origami</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
The students will be able
•to gain a solid understanding of concepts and methods of DNA-focused synthetic biology
•to discuss the project work in the global context of the field (review of recently</td></tr>
</table>

	published literature) with supervisors and students •to present a research topic to fellow students and supervisors •to collect, interpret, and evaluate data obtained through application of synthetic biology methods •to work as a team on a joint scientific project
4	**Requirements for Participation** Passing of module “Basics in Synthetic Biology”
5	**Form of Examination** Course Examination: • [10-42-0006-pr] (Study Examination, Laboratory Notebook, Standard) • [10-42-0006-vl] (Technical Examination, Written Exam, Duration 60 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exams. Compulsory attendance in 75% of the practical course. Acquisition and development of laboratory skills depends on working in the laboratory during the practical course.
7	**Grading** Course Examination: • [10-42-0006-pr] (Study Examination, Laboratory Notebook, Weight: 50%, Standard) • [10-42-0006-vl] (Technical Examination, Written Exam, Weight: 50%, Standard)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature**
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name
Applied computational modeling and analysis</td></tr>
<tr><td>Module no.
18-kp-3020</td><td>Credit Points
6 CP</td><td>Workload
180 h</td><td>Self-study
90 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. techn. Heinz Köppl</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>18-kp-3020-se</td><td>Applied computational modeling and analysis</td><td>4</td><td>Seminar</td><td>5</td></tr>
<tr><td>18-kp-3020-vl</td><td>Applied computational modeling and analysis</td><td>2</td><td>Lecture</td><td>1</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
The module provides an introduction to modeling and analysis approaches relevant to synthetic biology. It builds on the mathematical basis provided in the module “mathematical foundations of modeling and analysis”. Apart from short introductory lectures, practical programming of respective algorithms will be the main modality to learn the subject. The course covers purely data-driven methods from biostatistics and machine learning but also first-principle modeling approaches from biophysics and biochemistry. Concrete scientific problem statements will used to learn about the modeling and analysis algorithms.
• Introduction to scientific programming using Julia
• Introduction to biostatistics, bioinformatics and machine learning
• Deterministic and stochastic approaches for modeling reaction networks
• Thermodynamic analysis of reactions networks
• Principles of molecular dynamics, structure prediction
• Statistical methods for structure prediction
• Numerical solution and simulation methods</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
Students gained an overview of relevant computational approaches in the area of synthetic biology. They can categorize approaches and find dedicated literature for an in-depth coverage.
They are able to understand new modeling and analysis algorithms and are able to</td></tr>
</table>

	implement them on their own in a programming language of choice. They know how to practically handle real experimental data, analyze the data and utilize data with a modeling project. They are able to work in a team efficiently to make progress on a scientific problem.
4	**Requirements for Participation** Passing of module “Basics in Synthetic Biology”
5	**Form of Examination** Final Module Examination: • Module Examination (Technical Examination, Presentation, Standard)
6	**Requirements on the Award of Credit Points** Passing the exams. Compulsory attendance in 75% of the seminar. A focus of the module is on making progress on a scientific problem in a team. For this purpose, it is necessary that the team members spend time together as a team.
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, Presentation, Weight: 100%, Standard)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature** • Neil Jones & Pavel Pevzner. An Introduction to bioinformatics algorithms, MIT Press, 2004 • Daniel Beard & Hing Qian. Chemical Biophysics, Cambridge University Press, 2010 • Darren Wilkinson. Stochastic modeling for systems biology, CRC Press, 2006 • Kevin P. Murphy. Machine Learning – A probabilistic perspective, MIT Press, 2012
10	**Comment**

Module Description

Module name Research Internship						
Module no. 10-42-0007	**Credit Points** 15 CP	**Workload** 450 h	**Self-study** 120 h	**Duration** 1 Semester	**Frequency** Every semester	
Language of Instruction English			**Person responsible for the Module** Vice Chairperson, Academic Affairs			

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-42-0007-pr	Research Internship	15	Practical / Lab / Internship	45

2 Study Content

12-week internship, which is usually carried out in one of the working groups of the lecturers involved in the study program. The content of the in-depth work is to be determined in consultation with the respective head of the working group and is oriented towards current issues from the research area of the university lecturer. Students are guided to work on the topic independently as far as possible. The students present the results of their work in a seminar.

3 Learning Outcomes

Following completion of the module, students will be able to:

- work on complex synthetic biology problems under guidance;
- describe and apply new methods;
- document their work scientifically and discuss and critically reflect on it in the light of current scientific knowledge;
- present their work in front of a professional audience.

4 Requirements for Participation

none

5 Form of Examination

Final Module Examination:

- Module Examination (Technical Examination, written Examination, Standard)

6 Requirements on the Award of Credit Points

Passing the exams. Compulsory attendance in 75% of the practical course. Acquisition and development of laboratory skills depends on working in the laboratory during the practical course.

7	**Grading** Final Module Examination: • Module Examination (Technical Examination, Laboratory Notebook, Weight: 100%, Standard)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature**
10	**Comment**

Module Description

Module name Advanced Design Project					
Module no. 16-	**Credit Points** 6 CP	**Workload** 180 h	**Self-study** 60 h	**Duration** 1 Semester	**Frequency** Every semester
Language of Instruction German/English			**Person responsible for the Module** Vice Chairperson, Academic Affairs		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	Advanced Design Project	6	Project	7

2 Study Content

Aktuelle Aufgabenstellungen aus dem Fokus der anbietenden Fachgebiete. Prüfung: Jeder hauptamtliche Professor oder jede hauptamtliche Professorin des Fachbereichs Maschinenbau.

Current research topic from the general area of the administering institute. Examination: Every fulltime professor of the Department of Mechanical Engineering

3 Learning Outcomes

Nachdem die Studierenden die Lerneinheit erfolgreich abgeschlossen haben, sollten sie in der Lage
sein:
1. Eine Gestaltungsaufgabe mithilfe der Entwicklungsmethodik des Maschinenbaus zu lösen oder eine komplexe, ergebnisoffene Forschungsfrage in Zusammenarbeit mit weiteren Personen zu analysieren, zu strukturieren, analytische und/oder numerische und/oder experimentelle Methoden auszuwählen, Lösungsvarianten zu generieren, zu bewerten und auszuwählen
2. Ggf. komplexe Probleme der industriellen Praxis und /oder der Forschung zu modellieren und zu simulieren.
3. Im Team Lösungsvarianten zu finden und zu bewerten.
4. Die Grundzüge der Arbeits- und Zeitplanung bei komplexen Aufgaben gegebenenfalls wiederholt zu praktizieren.
5. Unterschiedliche Rollen in einem Team auszufüllen.
6. Divergierende Standpunkte zu vertreten und eine Problemlösung zu entwickeln.
7. Die Problemlösung kritisch zu reflektieren.
Erläuterung: Bei der Gestaltungsaufgabe kann es sich beispielsweise um eine Konstruktion oder um die Entwicklung eines Prozesses, einer Regelungsstrategie oder eines Bedienkonzeptes handeln.

On successful completion of this module, students should be able to:
1. Solve a creation task with the help of the design methodology of mechanical engineering or to analyse and structure a complex and open ended research question in collaboration with other people, to Select and apply analytic and/or numeric and/or experimental methods to the problem, to generate variant solutions, and to assess and select them.
2. Model and simulate complex problems of industrial practice and research, if necessary.

	3. Find and evaluate solution variants within a team. 4. Create and follow a work and time schedule to complete the complex problems, adjusting as necessary. 5. Perform different roles in a team. 6. Represent and assess divergent positions and develop a solution for the problem. 7. Critically reflect the solution to the problem. Explanation: The design task might be a mechanical design or the development of a process, a control strategy or a Human-Machine-Interface.
4	**Requirements for Participation** Mögliche Voraussetzungen werden vom anbietenden Fachgebiet bei der Aufgabenstellung angegeben. Possible prerequisites will be prescribed by the individual institute supervising the project. Passing of module “Basics in Synthetic Biology”
5	**Form of Examination** Sonderform: Schriftliche Ausarbeitung (80 %) und mündliche Prüfung (20 %, 5-15 min pro Person, variiert nach Gruppengröße; Gruppenprüfung mind. 30 min) • Special type: Written report (80 %) and oral exam (20 %, 5-15 min per person, varies after group size; group examination mind. 30 min).
6	**Requirements on the Award of Credit Points** Bestehen der Prüfungsleistung / Passing the examination.
7	**Grading** Fachprüfung (100%); Standard (Ziffernote) • Technical Examination (100%); Standard (Number grades)
8	**Usability of the Module** Master MB ADP Master AE ADP Master PST ADP Mechatronik M.Sc. Synthetic Biology
9	**Literature** Abhängig vom Projekt; wird vom Fachgebiet bekannt gegeben. Will depend on topic; available upon announcement.
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Intercultural and Project Mentoring</td></tr>
<tr><td>Module no.
10-42-0008</td><td>Credit Points
5 CP</td><td>Workload
150 h</td><td>Self-study
100 h</td><td>Duration
2 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
PD Dr. Ulrike Homann</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0008-pj</td><td>Mentoring</td><td>4</td><td>Project</td><td>4</td></tr>
<tr><td>10-42-0008-se</td><td>Mentoring Skills Workshop</td><td>1</td><td>Seminar</td><td>1</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Mentoring Skills Workshop:
Intercultural competence training, providing feedback, effective communication, moderate and develop teams, challenges in mentoring.
Mentoring:
Supervise and support a small team of students during their first semester of the M.Sc. Synthetic Biology study program. This includes supporting students during the module “Intercultural Skills and Project Management” and “Basics in Synthetic Biology – Lab Course”.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
Following completion of the module, students will be able to:
•reflect their role and responsibilities as a mentor
•provide supportive feedback
•plan mentoring sessions
•illustrate methods to resolve communication challenges
•recognize and name cultural differences and to draw conclusions from them</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:
• Module Examination (Study Examination, Portfolio, Passed / Not Passed)</td></tr>
<tr><td>6</td><td colspan="6">Requirements on the Award of Credit Points
Passing the exams. Compulsory attendance in 75% of the seminar and project. The seminar prepares students for their mentoring role and for supervising students in a practical course. For this purpose, a focus of the seminar is on simulations of critical</td></tr>
</table>

	situations in mentoring and supervision which requires attendance. This also holds true for mentoring and supervision of mentees during the project.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Portfolio, Weight: 100%, Passed / Not Passed)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature**
10	**Comment**

Module Description

<table>
<tr><td colspan="8">Module name
Master-Thesis</td></tr>
<tr><td>Module no.
10-42-4000</td><td>Credit Points
27 CP</td><td>Workload
810 h</td><td>Self-study
810 h</td><td>Duration
2 Semester</td><td colspan="3">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="5">Person responsible for the Module
Vice Chairperson, Academic Affairs</td></tr>
<tr><td>1</td><td colspan="7">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="7">Study Content
Working on a scientific problem under supervision. Independent planning, execution and evaluation of new experimental or theoretical studies on a current scientific topic. The problem as well as the results are documented in writing together with a critical interpretation of the data.</td></tr>
<tr><td>3</td><td colspan="7">Learning Outcomes
Following completion of the module, students will be able to:
• work independently on complex synthetic biology problems and consider different approaches of solving them;
• develop problem-solving strategies;
• document their work scientifically and to discuss and critically reflect on it in the light of current scientific knowledge;
• present their work</td></tr>
<tr><td>4</td><td colspan="7">Requirements for Participation</td></tr>
<tr><td>5</td><td colspan="7">Form of Examination
Final Module Examination:
• Module Examination (Thesis, Standard, number grades)</td></tr>
<tr><td>6</td><td colspan="7">Requirements on the Award of Credit Points
Passing the exam.</td></tr>
<tr><td>7</td><td colspan="7">Grading
Fachprüfung (100%); Standard (Ziffernote)</td></tr>
</table>

	Thesis (100%); Standard (Number grades)
8	**Usability of the Module** M.Sc. Synthetic Biology
9	**Literature**
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name
Oral Presentation of Master-Thesis</td></tr>
<tr><td>Module no.
10-42-4000</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Vice Chairperson, Academic Affairs</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Oral presentation of the results of the Master Thesis followed by a scientific discussion.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
Following completion of the module, students will be able to:
• prepare scientific results for presentation
• present scientific results orally in English</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
• Presentation of results followed by discussion (40 min).</td></tr>
<tr><td>6</td><td colspan="6">Requirements on the Award of Credit Points
Passing the exam.</td></tr>
<tr><td>7</td><td colspan="6">Grading
Fachprüfung (100%); Standard (Ziffernote)
Oral Presentation (100%); Standard (Number grades)</td></tr>
<tr><td>8</td><td colspan="6">Usability of the Module
M.Sc. Synthetic Biology</td></tr>
<tr><td>9</td><td colspan="6">Literature</td></tr>
<tr><td>10</td><td colspan="6">Comment</td></tr>
</table>

Modulhandbuch
M.Sc. Synthetic Biology

Elective Area
Catalogue Biology

Module Description

<table>
<tr><td colspan="7">Module name

Introduction into Immunology</td></tr>
<tr><td>Module no.
10-42-0210</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Vice Chairperson, Academic Affairs</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0210-se</td><td>Introduction into Immunology - Seminar</td><td>1</td><td>Seminar</td><td>1</td></tr>
<tr><td>10-42-0210-vl</td><td>Introduction into Immunology - Lecture</td><td>2</td><td>Lecture</td><td>1</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Lecture:
Our immune system efficiently protects us from a plethora of different pathogens and toxins. During the last 150 years advances in immunology have revolutionized our understanding of the cellular and molecular mechanisms underlying these immune responses.
The module is designed to provide an introduction into the field of immunology and addresses the following topics:
•The development, structure, and molecular function of the cells belonging to the innate and adaptive immune system
•The molecular mechanisms of “self” tolerance, infection, and immunity
•The interaction of tumors with the immune system

Seminar:
The seminar will take place after the presence appointments as an online seminar. Within this seminar, the students will gain insight into the ongoing immunologic research of the lecturers, have the opportunity to further deepen the acquired knowledge with a guest lecture taken from clinical practice, and are informed about career options in biology. For this, the students will be provided pre-recorded videos. These videos will later on be discussed with the students. During this appointment the students will also have the opportunity to ask questions about the final test.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After successfully completing the module, the students will be able to:
•Explain the basic principles of immunology
•Understand the research questions currently worked on by the lecturers and have a general understanding of the complexity of immunological research
•Understand the basic concepts of more complex immunological topics like tolerance,</td></tr>
</table>

	infection, and cancer
4	**Requirements for Participation** none
5	**Form of Examination** Final Module Examination: • Module Examination (Study Examination, Written Exam, Duration 60 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Written Exam, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M.Sc.), Biomolecular Engineering (M.Sc.) Synthetic Biology (M.Sc.)
9	**Literature** A script covering the lecture part will be supplied at the beginning of the module.
10	**Comment**

Module Description

Module name **Immunotherapies against cancers**					
Module no. 10-12-0244	**Credit Points** 3 CP	**Workload** 90 h	**Self-study** 60 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Vice Chairperson, Academic Affairs		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-12-0244-pj	Immunotherapies against cancers	3	Lecture	2

2 Study Content

During the 12 seminars (1,5h each) students will learn the current clinical approaches to treat cancers. Introduction of the principles of (i) the biological mechanisms involved in vaccinations and their immunological potency (ii) the current standard of cares (immunotherapy, chemotherapy, radiotherapy) to treat cancer patients (iii) the developed RNA based vaccines in cancers. Example of research project will be described, which allowed to translate a pre-clinical study in several clinical trials for cancer patients. Students will learn the first concepts to draft a research grant proposal.

3 Learning Outcomes

After successfully completing this course, students will be able to:

- to explain the principles of immunotherapies
- to explain the types of preclinical cancer research and immunotherapies
- to be able to classify current questions of oncoimmuno research
- to interpret, to formulate question and present scientific literature

4 Requirements for Participation

none

5 Form of Examination

Final Module Examination:

- Module Examination (Study Examination, Presentation, Duration 20 min, Standard)

6 Requirements on the Award of Credit Points

Passing the exam.

7 Grading

Final Module Examination:

	• Module Examination (Study Examination, Presentation, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M. Sc.) Technische Biologie (M. Sc.) Biomolecular Engineering (Molekulare Biotechnologie) (M. Sc.) Synthetic Biology (M.Sc.)
9	**Literature** Kranz et al., Nature 2016 Jun 16;534(7607):396-401 ; Sahin et al., Science 2018 359, 1355–1360; Mellman et al. 2011 Dec 21;480(7378):480-9. Romero et al. SciTransl Med. 2016 Apr 13;8(334):334ps9
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Plant Biotechnology - Lecture</td></tr>
<tr><td>Module no.
10-02-0202</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. Heribert Warzecha</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-02-0002-vl</td><td>Plant Metabolic Engineering - Lecture</td><td>3</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Plants produce a plethora of low molecular weight compounds with highly diverse functionalities (e. g., alkaloids, flavonoids, or terpenes). They are of tremendous importance as, very often, they exhibit pronounced pharmacological activities or are applicable as flavors, fragrances, or basic/fine chemicals.
Within this lecture, biosynthetic routes of various compound classes will be discussed. The featured topics further include distribution of the metabolites of interest within the plant kingdom as well as their function.
Moreover, use of secondary metabolites in medicine and technology will be presented and the pharmacology of selected compound classes discussed in detail.
Finally, concepts of metabolic engineering and synthetic biology for the production and modification of plant-derived compounds will be introduced.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After successfully completing the course, students will be able to:
•differentiate between various biosynthetic routes of plant secondary metabolism; classify compound families and their representatives
•describe the existing/modern strategies of biosynthetic pathway elucidation and engineering</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, oral Examination, Duration 30 min, Standard)</td></tr>
<tr><td>6</td><td colspan="6">Requirements on the Award of Credit Points</td></tr>
</table>

	Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M.Sc.) Biomolecular Engineering (M.Sc.) Synthetic Biology (M.Sc.)
9	**Literature** Dewick, Paul (2009): Medicinal Natural Products. Wiley. ISBN 978-0-470-74168-9 Samuelsson, G. & Bohlin, L. (2010): Drugs of Natural Origin. Taylor & Francis. ISBN 978-91-976510-5-9
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

RNA Structure and Function</td></tr>
<tr><td>Module no.
10-42-0215</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. Beatrix Süß</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0215-se</td><td>RNA Structure and Function - Seminar</td><td>2</td><td>Seminar</td><td>1</td></tr>
<tr><td>10-42-0215-vl</td><td>RNA Structure and Function - Lecture</td><td>1</td><td>Lecture</td><td>1</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Lecture:
Basic knowledge in the field of RNA biology is taught. The lecture is divided into two parts.
RNA structure
This part, addresses the following topics: Folding of RNA molecules (introduction, how it comes about, methods used for its analysis); importance of correct folding explained by using functional examples, e.g. ribozymes.
RNA function
Presentation of examples of RNA-based regulatory mechanisms from pro- and eukaryotes, e.g. sRNAs vs. miRNAs.

Seminar:
In the seminar the students will have the opportunity to further deepen the knowledge acquired in the lecture through specialist literature. For this purpose, current publications are handed out, which are discussed collectively. The students will present a method of RNA research that is critical for the topic.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After successfully completing the module, the students have
• acquired comprehensive knowledge in the field of RNA biology,
• have become acquainted with current research methods and
• are able to comprehend and critically evaluate specialist literature.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination</td></tr>
</table>

	Final Module Examination: • Module Examination (Study Examination, Presentation, Duration 30 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Presentation, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M.Sc.), Biomolecular Engineering (M.Sc.) Synthetic Biology (M.Sc.)
9	**Literature**
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Synthetic Protein Sciences</td></tr>
<tr><td>Module no.
10-42-0220</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. Viktor Stein</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0220-vl</td><td>Synthetic Protein Sciences</td><td>3</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Summary: The module provides a theoretical overview of different experimental strategies to equip proteins with tailored properties and functions. To this end, the module discusses both the state-of-the-art based on the contemporary primary scientific literature, but also takes into account the historic development of individual technologies and conceptual approaches. In terms of specific applications, the main focus is on the construction of tailored protein binders and enzymes and how they can be effectively tailored for use in biotechnology, synthetic biology or as tools in basic research.
•Lecture 1: Introduction and overview to protein engineering: How are proteins equipped with tailored properties and functions? Which type of structural properties and functions are critical from a biotechnological point of view? What are the economic and scientific drivers underlying protein engineering?
•Lecture 2: Computer-aided protein design: To what extent can the structural and functional properties of a protein be modified by rational means using computer-aided methods? Protein engineering versus protein re-engineering? Protein archaeology: Phylogenetic approaches to "resurrect" proteins by means of ancestral gene resurrection. What do ancestral proteins differ from present ones? How does ancestral gene resurrection assist protein engineering?
•Lecture 3: Protein engineering in real time: Molecular and cellular basis of the immune response to equip antibodies with tailored binding specificities (e.g. hybridoma technology, humanisation of antibodies by exchange of VH/VL and CDRs; application of next-generation sequencing to simplify the selection of monoclonal antibodies; Use of CRISPR-Cas9 engineer hybridoma cells).
•Lecture 4: Construction and selection of recombinant protein binders (e.g. antibody fragments, ankyrin repeat proteins, anticalins, fibronectins and affinity clamps) by means of display systems (e.g. phage, yeast, ribosome, mRNA and DNA display with special consideration of molecular genetic aspects, in particular the connection between genotype and phenotype) and their application in therapy, medical diagnostics or as a molecular tool in basic research.
•Lecture 5: Engineering enzymes by immunisation (e.g. catalytic antibodies), using display systems (e.g. single turn-over selections) or in water-in-oil emulsions (e.g. in vitro compartmentalisation). Case studies are illustrated with DNA modifying enzymes (e.g. DNA methyltransferases, DNA polymerases, DNA ligases) and enzymes to degrade</td></tr>
</table>

	anthropogenic substances (e.g. phosphotriesterases and catalytic antibodies). •Lecture 6: Development and application of genetic screening and selection systems to resolve catalytic functions in live cell; Exploiting growth-based selection strategies (e.g. genetic complementation) and molecular reporter systems to developing high-throughput assays; Particular consideration is given to effectively control the selective pressure inside cells. Case studies are illustrated with enzymes of the shikimate pathway (e.g. chorismate mutase and dehydroshikimate dehydratase) while illustrating significance for metabolic engineering. •Lecture 7: Strategies inspired by natural protein evolution to effectively construct new enzyme functions by means of genetic drift and iterative mutation-selection cycles in low throughput. Particular attention is paid to "neutral" mutations in particular their effect on the evolvability of enzymes regarding substrate promiscuity and thermodynamic stability. Case studies are illustrated with enzymes to degrade anthropogenic substances (e.g. antibiotics and pesticides). •Lecture 8: Development and application of continuous evolution systems to engineer tailored fluorescent proteins, protein binders or enzymes (e.g. in B-cells, by means of multiplex automated genome engineering (MAGE) and phage assisted continuous evolution (PACE)). A particular focus concerns strategies to selectively mutate DNA directly inside cells, and how to implement continuous screening and selection process.
3	**Learning Outcomes** Following completion of the theory module students should: (1) Acquire a detailed and comprehensive overview of the many different conceptual and experimental approaches to engineer proteins (including key primary literature). (2) Understand and critically evaluate experimental strategies how proteins can be equipped with distinct structural properties and functions (3) Be familiar with the molecular mechanisms that underlie genetic diversification strategies and approaches to assay binding and catalytic functions in high-throughput (4) Devise experimental strategies to tailor proteins for distinct biotechnological applications.
4	**Requirements for Participation** none
5	**Form of Examination** Final Module Examination: • Module Examination (Study Examination, Written Exam, Duration 60 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Written Exam, Weight: 100%, Standard)
8	**Usability of the Module**

	Biologie (M. Sc.) Technische Biologie (M. Sc.) Biomolecular Engineering (Molekulare Biotechnologie) (M. Sc.) Synthetic Biology (M.Sc.)
9	**Literature** Aktuelle Primärliteratur (siehe beigefügte Liste)
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Applied Immunology</td></tr>
<tr><td>Module no.
10-42-0221</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Vice Chairperson, Academic Affairs</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0221-vl</td><td>Applied Immunology - Lecture</td><td>3</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
In 6 lectures of 90 minutes each, students will get a short introduction into the innate and adaptive immune system. Furthermore, they will gain an insight into applied research topics in the field of immunology.
The lecture “Biopharmaceuticals – Severe Side Effects?” will uncover treatment options for rare diseases such as hemophilia A and will demonstrate which severe side effects can results from the application of biopharmaceuticals. Via the lecture “Vaccination – How does it Work“, students are introduced into the field of vaccination and will get an overview about historical facts, standard vaccination methods, and novel vaccination strategies using latest updates from the literature as examples. Based on that Dr. Patricia Gogesch will give a guest lecture and report about the process of the development and approval of a novel vaccine against beta herpesvirus human cytomegalovirus (HCMV).
The lecture „The Work of J. Murray und T. Donnal: Transplants make History“ gives an overview about the discoveries of Joseph Murray und Thomas Donnal on solid organ and stem cell transplantation which revolutionized medicine and were awarded with the Nobel Prize in 1990. Finally, the role and function of the Paul-Ehrlich-Institut will be explained.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After finishing the module students got a first insight into the complex mechanisms underlying the innate and adaptive immune system. This will allow them to understand more advanced applied immunological research topics. Students will have a good overview about current biomedical research and difficulties regarding the development of biopharmaceuticals and are able to discuss about topics such as the development of novel vaccination strategies in a scientific context.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:</td></tr>
</table>

	• Module Examination (Study Examination, Written Exam, Duration 60 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Written Exam, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M.Sc.) Biomolecular Engineering (M.Sc.) Synthetic Biology (M.Sc.)
9	**Literature**
10	**Comment**

Module Description

Module name

Biomolecular Design

Module no.	Credit Points	Workload	Self-study	Duration	Frequency
10-42-0105	3 CP	90 h	45 h	1 Semester	Every 2. semester

Language of Instruction	Person responsible for the Module
English	Prof. Dr. Kai Hamacher

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-42-0105-ue	Biomolecular Design - Exercise	1	Exercise	1
10-42-0105-vl	Biomolecular Design - Lecture	2	Lecture	2

2 Study Content

The lecture covers basics of statistical mechanics of biomolekular systems (protein folding and stability, molecular binding processes, mathematical models of evolutionary dynamics and analysis). In addition methods of simulation and in-silico design ideas by multi-scale simulations. An introduction to molecular docking is also given. In the exercises those basics are more elaborated on.

3 Learning Outcomes

After successfully finishing the module, students have a working command over simulation and in-silico-design methods and their chemical and physical basics, as well as the systems biological rammifications. They are enabled to use standard software packages in the real of molecular dynamics simulations, docking software, and 3D-structure modeling. Furthermore, they understand and can leverage interfaces between the various methods and software systems to gain quantitative and qualitative insight into the to-be-designed molecules.

4 Requirements for Participation

none

5 Form of Examination

Final Module Examination:

- Module Examination (Study Examination, oral Examination, Duration 20 min, Standard)

6 Requirements on the Award of Credit Points

Passing the exam.

7 Grading

	Final Module Examination: • Module Examination (Study Examination, oral Examination, Weight: 100%, Standard)
8	**Usability of the Module** Synthetic Biology (M. Sc.)
9	**Literature** Schlick, T. (2010): Molecular Modeling and Simulation. Springer. Branden, C., and Tooze, J. (1998): Introduction to Protein Structure. Garland Publishing. Van Vranken, D., and Weiss, G. (2013): Introduction to Bioorganic Chemistry and Chemical Biology. 1Garland Publishing.
10	**Comment**

Module Description

Module name **Immuno Pathology**					
Module no. 10-42-0222	**Credit Points** 3 CP	**Workload** 90 h	**Self-study** 60 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Vice Chairperson, Academic Affairs		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-42-0222-se	Scientific illustration on the example of immune pathologic diseases - Seminar	1	Seminar	1
10-42-0222-vl	Immuno Pathology - Lecture	2	Lecture	1

2 Study Content

Lecture:
The function of our immune system is to protect us from different pathogens and toxins as well as cancer. Although our immune system usually efficiently protects us from these dangers, its actions can also be detrimental. Diseases arising from either over-function, under-function, or malfunction of the immune system are called immune pathological reactions. Additionally, pathogens can evade or overcome the defense mechanisms of our immune system and cause great damage during either acute or chronic infections.
In the course of the module, the students first get a short introduction into the composition and normal function of the immune system. Building on this, we will introduce different strategies how pathogens are able to evade our immune system using examples of some of the most common, successful, and deadly pathogens.
We will also look at the principles of immune pathological reactions as well as the currently available treatment options. For this, single lectures will be dedicated to autoimmune reactions, allergies, transplant rejections, and immune deficiencies (primary and acquired). In a pre-recorded guest lecture given by Dr. med. Tobias Möller, the students will get a closer look at a case study dealing with immune deficiencies in clinical practice.

Seminar:
In the accompanying seminar, the students will learn to conceptually design and technically produce their own infographics using different graphic design programs (commercial and cost-free alternatives available for both Mac and PC).
For the final exam, the students will choose one disease introduced in the lecture part and prepare and present a short talk about this disease using only their own self-prepared graphics.
The general principles of using graphic design programs will be demonstrated by the lecturer at the beginning of the module. During the course, the students can then generate their own graphics and discuss them with the lecturer before the final exam.

3	**Learning Outcomes** After successfully completing the module, the students will be able to: •Understand under which circumstances and by which mechanisms the actions of our immune system can cause diseases •Reflect (I) which strategies are currently used for the treatment of pathological immune reactions and (II) what their advantages and disadvantages are •Have a technical and conceptual understanding of how to design their own graphics to transport complex scientific problems in simple pictures
4	**Requirements for Participation** none
5	**Form of Examination** Final Module Examination: • Module Examination (Study Examination, Presentation, Duration 20 min, Standard)
6	**Requirements on the Award of Credit Points** Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, Presentation, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M.Sc.), Biomolecular Engineering (M.Sc.) Synthetic Biology (M.Sc.)
9	**Literature** Janeway´s Immunobiology, Taylor & Francis Ltd.; 9th revised edition, ISBN-10: 0815345518 A script covering the lecture part will be supplied at the beginning of the module
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Clinical Immunology – The House MD Seminar</td></tr>
<tr><td>Module no.
10-42-0227</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
75 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Vice Chairperson, Academic Affairs</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>10-42-0227-se</td><td>Clinical Immunology</td><td>3</td><td>Seminar</td><td>1</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Defects of the immune system, hypersensitivity reactions (allergies and autoimmunity), chronic inflammation, cancer, and infections with different pathogens play a prominent role in the clinic. As these diseases often show a variable presentation of disease symptoms, as well as complex interactions of the involved immune cells, non-immune cells, and pathogens among each other, these diseases are often very hard to diagnose. In six seminars of three hours each the students will be introduced into clinically relevant immune pathologies (allergies and autoimmunity, cancer, infections) using carefully chosen episodes of the TV series “House MD”. Here, the clinical cases will be introduced by the lecturers, symptoms will be collected together with the students, analyzed, and a diagnosis and treatment will be worked out.
All seminars are designed to be strongly interactive with enough room for questions and discussion. This results in an intensive and critical reflection of the provided knowledge.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After completing the module, the students will have an in-depth knowledge about immunological and immune pathological diseases as well as an understanding of the underlying mechanisms. The problem-solving strategies learned in the module will help them to analyze, interpret, and solve complex problems.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
The final exam will be performed as a role play (either in presence or online). Here, groups of students (max. five persons per group) will be tasked with both recognizing and asking for symptoms that are presented by actors. The students are assigned to make diagnoses and provide theoretical treatment options for the patients according to the acquired knowledge provided in the seminar. Every group will go through multiple rounds with their respective actor.</td></tr>
</table>

6	**Requirements on the Award of Credit Points** Passing the exam.
7	**Grading** Final Module Examination: • Module Examination (Study Examination, oral Examination, Weight: 100%, Standard)
8	**Usability of the Module** Biologie (M.Sc.), Biomolecular Engineering (M.Sc.) Synthetic Biology (M.Sc.)
9	**Literature** Janeway's Immunobiology 9th Edition (Garland Science)
10	**Comment**

Module Description

Module name **Constraint Logic Programming in Biotechnological/Biomolecular Engineering**					
Module no. 10-12-0225	**Credit Points** 3 CP	**Workload** 90 h	**Self-study** 45 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Prof. Dr. Kai Hamacher		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
10-12-0225-ue	Constraint Logic Programming in Biotechnological/Biomolecular Engineering - Exercise	1	Exercise	1
10-12-0225-vl	Constraint Logic Programming in Biotechnological/Biomolecular Engineering - Lecture	2	Lecture	2

2 Study Content

- Intracellular Circuits and Networks as Graphs, Boolean Networks
- logic relations in Prolog / Constraint Logic Programming (CLP)
- methods of inference and backtrack / CLP-methods / Constraint-Propagation

3 Learning Outcomes

- Successful participants will be able to actively model biological/biotechnological systems in a declarative programming language. They will command over applicable know-how how to analyze logical networks and graph descriptions
- Participants can model simple relations in Prolog and use CLP to solve combinatorial design problems

4 Requirements for Participation

none

5 Form of Examination

programming tasks (homework)

6 Requirements on the Award of Credit Points

Passing the exam.

7 Grading

Final Module Examination:

	• Module Examination (Study Examination, written Examination, Weight: 100%, Standard)
8	**Usability of the Module** Technische Biologie (M. Sc.); Biomolecular Engineering (M. Sc.) Informatik (M. Sc.), Physik (M. Sc.) Synthetic Biology (M.Sc.)
9	**Literature** •Introduction: http://www.learnprolognow.org/ •Software: http://www.swi-prolog.org/ ; https://github.com/mthom/scryer-prolog
10	**Comment**

Modulhandbuch
M.Sc. Synthetic Biology

Elective Area
Open Catalogue Engineering

Module Description

<table>
<tr><td colspan="7">Module name

Biofabrication and 3D-Bioprinting</td></tr>
<tr><td>Module no.
16-17-3284</td><td>Credit Points
4 CP</td><td>Workload
120 h</td><td>Self-study
90 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr.-Ing. Andreas Blaeser</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>16-17-3284-vl</td><td>Biofabrication and 3D-Bioprinting</td><td>4</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Introduction into Biofabrication and Tissue Engineering; Basic concepts, selection and characterization of biofabrication technologies. Basic concepts, technical description and characterization of 3D-bioprinting technologies; Design of software and hardware for 3D-bioprinting systems; In-vitro and in-vivo applications of biofabrication and 3D-bioprinting technologies.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
On successful completion of this module, students should be able to:
1. Explain and distinguish fundamental biofabrication technologies and the bioprinting process chain.
2. Compare various biofabrication technologies, naming their advantages and disadvantages for specific use cases.
3. Analyze the physical processes and phenomena of fluid transport in particular 3D-bioprinting technologies.
4. Make suggestions for the tissue-specific application of various biofabrication technologies based on characteristic features and selection criteria both orally and written.
5. Make predictions for the applicability and prospects of specific biofabrication and 3D-bioprinting technologies regarding used cell types and target tissue.
6. Name example applications of biofabrication and 3D-bioprinting technologies.
7. Explain the key components and elements of 3D-bioprinting software and hardware.
8. Name in-vitro and in-vivo applications of these technologies.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:</td></tr>
</table>

	• Module Examination (Technical Examination, optional, Standard) Facultative: Oral (30 min) or written exam 60 min. Will be announced at the beginning of the term depending on the circumstances (number of students, pandemic etc.).
6	**Requirements on the Award of Credit Points** Passing the examination.
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, optional, Weight: 100%, Standard)
8	**Usability of the Module** WPB Master MB II (Kernlehrveranstaltung aus dem Maschinenbau) WPB Master PST III (Fächer aus Natur- und Ingenieurwissenschaft für Papiertechnik) M.Sc. Synthetic Biology
9	**Literature** The current lecture notes can be downloaded from moodle. Reference is made to other relevant literature (online available)
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Biomaterials and Tissue Engineering</td></tr>
<tr><td>Module no.
16-17-3294</td><td>Credit Points
4 CP</td><td>Workload
120 h</td><td>Self-study
90 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
German</td><td colspan="4">Person responsible for the Module
Prof. Dr.-Ing. Andreas Blaeser</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>16-17-3294-vl</td><td>Biomaterials and Tissue Engineering</td><td>4</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Biological fundamentals: anatomy of eukaryotic cells; cell culture fundamentals; interaction of cells and biomaterials in 2 and 3D; biomaterials and hydrogels for tissue culture; classification; composition and selection of biomaterials for culture of soft and hard tissue; characterization methods of biomaterials and hydrogels (rheological, mechanical and biological characterization); tissue culture in bioreactors; static and dynamic cell culture in culture dishes and various bioreactors; mechanobiological aspects of tissue culture.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
On successful completion of this module, students should be able to:
1. Explain and classify biological fundamentals and applications of biomaterials.
2. Select biomaterials for the cultivation of soft and hard tissue and apply them in a use case.
3. Compare and contrast biomaterials in terms of their biomedical applicability.
4. Assess the interaction of cells and biomaterials in 2 and 3D.
5. Choose and apply suitable characterization methods for biomaterials and hydrogels according to appropriate criteria.
6. Evaluate different types of tissue culture in bioreactors.
7. Summarize key mechanobiological aspects of tissue culture.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, optional, Standard)</td></tr>
</table>

	Facultative: oral (30 min) or written (60 min) Will be announced at the beginning of the term depending on the circumstances (number of students, pandemic etc.).
6	**Requirements on the Award of Credit Points** Passing the examination.
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, optional, Weight: 100%, Standard)
8	**Usability of the Module** WPB Master MB II (Kernlehrveranstaltung aus dem Maschinenbau) WPB Master PST III (Fächer aus Natur- und Ingenieurwissenschaft für Papiertechnik) M.Sc. Synthetic Biology
9	**Literature** The current lecture notes can be downloaded from moodle. Reference is made to other relevant literature (online available)
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Tutorial Application and characterization of biomaterials</td></tr>
<tr><td>Module no.
16-17-3304</td><td>Credit Points
4 CP</td><td>Workload
120 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
German/English</td><td colspan="4">Person responsible for the Module
Prof. Dr.-Ing. Andreas Blaeser</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>16-17-3304-tt</td><td>Tutorial Application and characterization of biomaterials</td><td>4</td><td>Tutorium</td><td>4</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Fabrication of hydrogels and biomaterial samples; Rheological characterization of hydrogels and biomaterials (viscosity, surface tension, viscoelastic behavior, polymerization time), Mechanical characterization of hydrogels and biomaterials (modulus of elasticity, tensile strength, compressive strength).</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
On successful completion of the course unit, the students should be able to:
1.Explain and differentiate the basic methods for the synthesis of hydrogels.
2.Know, produce and characterize hydrogel formulations with different mechanical, rheological and biological properties.
3.Compare different hydrogels and biomaterials, naming advantages and disadvantages for special applications.
4.Offer proposals for tissue-specific applications of different hydrogels and biomaterials based on characteristic features and selection criteria.
5.Make predictions on the polymerisation behaviour (sol-gel and gel-sol transition) of different hydrogels based on experimental analyses.
6.Name exemplary in-vitro and in-vivo applications of the different classes of materials and to explain them using a simple example.
7.Explain the essential components and crosslinking mechanisms of hydrogels.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, Special Form, Standard)</td></tr>
</table>

	Special form: presenting results in a colloquium; creating a handout
6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	**Usability of the Module** Master MB Tutorium Master AE Tutorium Master Mechatronik M.Sc. Synthetic Biology
9	**Literature** Educational material and references will be supplied.
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Tutorial 3D-bioprinting technology and its applications</td></tr>
<tr><td>Module no.
16-17-3314</td><td>Credit Points
4 CP</td><td>Workload
120 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
German/English</td><td colspan="4">Person responsible for the Module
Prof. Dr.-Ing. Andreas Blaeser</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>16-17-3314-tt</td><td>Tutorial 3D-bioprinting technology and its applications</td><td>4</td><td>Tutorium</td><td>4</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content
Production of bioinks; design of 3D printable data sets using CAD and slicing software; 3D bioprinting process development; application of drop-on-demand based 3D-bioprinting and microextrusion based 3D-bioprinting.</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
On successful completion of the course unit, the students should be able to
1.Explain and differentiate the basic 3D bioprinting process chain (3D data set, bioink, slicing, 3D bio-printing).
2.Produce and describe bioinks and printable 3D datasets.
3.Compare different 3D bioprinting methods (drop-on-demand and microextrusion), naming the advantages and disadvantages for special applications.
4.Offer proposals for the tissue-specific application of different 3D-bioprinting technologies on the basis of characteristic features.
5.Make predictions on the post-printing survival rate of cells processed using different 3D-bioprinting techniques.
6.Name exemplary in-vitro and in-vivo applications of 3D- bioprinting technology and to transfer them into practice by means of a simple example.
7.Explain the essential elements and components of 3D-bioprinting software and hardware.</td></tr>
<tr><td>4</td><td colspan="6">Requirements for Participation
none</td></tr>
<tr><td>5</td><td colspan="6">Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, Special Form, Standard)</td></tr>
</table>

6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	**Usability of the Module** Master MB Tutorium Master AE Tutorium Master Mechatronik M.Sc. Synthetic Biology
9	**Literature** Educational material and references will be supplied.
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Lab-on-Chip Systems</td></tr>
<tr><td>Module no.
18-bu-2030</td><td>Credit Points
5 CP</td><td>Workload
150 h</td><td>Self-study
90 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Ph.D. Thomas Peter Burg</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>18-bu-2030-ue</td><td>Lab-on-Chip Systems</td><td>0</td><td>Practice</td><td>2</td></tr>
<tr><td>18-bu-2030-vl</td><td>Lab-on-Chip Systems</td><td>0</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content

• Bioanalytical methods
• Opportunities and fundamental limitations of miniaturization
• Technology of microfluidic systems
• The solid-liquid-interface
• Transport processes
• Biosensors
• Single molecule methods
• PCR-based micro-analytical systems
• Single-cell sequencing
• Flow cytometry
• Optofluidics
• Organ-on-Chip-Technologies
• Advanced microscopy techniques</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
Students will learn to evaluate and compare conventional and microfluidic bioanalytical methods for laboratory medicine and Point-of-Care applications. They become familiar</td></tr>
</table>

	with the underlying physical principles and scaling laws and learn to analyze the impact of miniaturization quantitatively. The skills acquired in this course will enable the participants to select appropriate techniques, to advance knowledge, and to address technological gaps in the biomedical sciences with the help of microfluidic systems.
4	**Requirements for Participation** none
5	**Form of Examination** Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) Performance will be evaluated based on a written final exam (duration: 90 min.). In case of low enrollment (<11), an oral exam may be offered instead (duration: 30 min.). The mode of the final exam (written or oral) will be announced at the beginning of each semester.
6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	**Usability of the Module** M.Sc. Biomedical Engineering M.Sc. Synthetic Biology
9	**Literature** Lecture notes and reading assignments on Moodle.
10	**Comment**

Module Description

<table>
<tr><td colspan="7">Module name

Bioinformatics II</td></tr>
<tr><td>Module no.
18-kp-2120</td><td>Credit Points
3 CP</td><td>Workload
90 h</td><td>Self-study
60 h</td><td>Duration
1 Semester</td><td colspan="2">Frequency
Every 2. semester</td></tr>
<tr><td colspan="3">Language of Instruction
English</td><td colspan="4">Person responsible for the Module
Prof. Dr. techn. Heinz Köppl</td></tr>
<tr><td>1</td><td colspan="6">Courses of the Module
<table>
<tr><th>Course no.</th><th>Course name</th><th>Workload (CP)</th><th>Form of Teaching</th><th>Contact Hours per Week</th></tr>
<tr><td>18-kp-2120-vl</td><td>Bioinformatics II</td><td>3</td><td>Lecture</td><td>2</td></tr>
</table></td></tr>
<tr><td>2</td><td colspan="6">Study Content

• Elementary methods of machine learning: Regression, classification, clustering (probabilistic graphical models)
• Analysis and visualization of high-dimensional data (multi-dimensional scaling, principal component analysis, embedding methods with deep neural networks, tSNE, UMAP)
• Data-driven reconstruction of molecular interaktion networks (Bayes nets, solution to Gausian graphical models, Causality analysis)
• Analysis of interaction networks (modularity, graph partitioning, spanning trees, differential networks, network motifs, STRING database, PathBLAST)
• Dynamical models of molecular interaction networks (stochastic Markov-modes, differential equations, Reaction rate equation)
• Elementary algorithms for structure determination of proteins and RNAs (Secondary structure prediction of RNAs, molecular dynamics, common simulators and force fields)</td></tr>
<tr><td>3</td><td colspan="6">Learning Outcomes
After successful completion of this module, students will be familiar with current statistical methods for analyzing high-throughput data in molecular biology. They know how to analyze high-dimensional data by reduction, visualization and clustering and how to find dependencies in these data. They know methods for dynamic description of molecular interactions. They are aware of common methods for structure prediction of biomolecules. Upon completion, students will be able to independently implement the presented algorithms in programming languages, such as Python, R or Matlab. In the area</td></tr>
</table>

	of communicative competence, students have learned to exchange information, ideas, problems and solutions in the field of bioinformatics with experts and with laypersons.
4	**Requirements for Participation** Recommended: Bioinformatics I
5	**Form of Examination** Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) The examination takes place in form of a written exam (duration: 90 minutes). If one can estimate that less than 11 students register, the examination will be an oral examination (duration: 30 min.). The type of examination will be announced in the beginning of the lecture.
6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	**Usability of the Module** M.Sc. Biomedical Engineering M.Sc. Synthetic Biology
9	**Literature**
10	**Comment** Bioinformatik I ist Bestandteil des B.Sc. Medizintechnik

Module Description

Module name **Signal Detection and Parameter Estimation**					
Module no. 18-zo-2050	**Credit Points** 8 CP	**Workload** 240 h	**Self-study** 180 h	**Duration** 1 Semester	**Frequency** Every 2. semester
Language of Instruction English			**Person responsible for the Module** Prof. Dr.-Ing. Abdelhak Zoubir		

1 Courses of the Module

Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
18-zo-2050-se	Signal Detection and Parameter Estimation	0	Seminar	4

2 Study Content

Signal detection and parameter estimation are fundamental signal processing tasks. In fact, they appear in many common engineering operations under a variety of names. In this course, the theory behind detection and estimation will be presented, allowing a better understanding of how (and why) to design "good" detection and estimation schemes.
These lectures will cover: Fundamentals
Detection Theory Hypothesis Testing Bayesian Tests
Ideal Observer Tests
Neyman-Pearson Tests
Receiver Operating Characteristics
Uniformly Most Powerful Tests
The Matched Filter Estimation Theory Types of Estimators
Maxmimum Likelihood Estimators
Sufficiency and the Fisher-Neyman/Factorisation Criterion
Unbiasedness and Minimum variance
Fisher Information and the CRB
Asymptotic properties of the MLE

3 Learning Outcomes

Students gain deeper knowledge in signal processing based on the fundamentals taught in DSP and EtiT 4. They will study advanced topics of statistical signal processing in the area of detection and estimation.
In a sequence of 4 lectures, the basics and important concepts of detection and estimation theory will be taught. These will be studied in dept by implementation of the methods in MATLAB for practical examples. In sequel, students will perform an independent literature research, i.e. choosing an original work in detection and estimation theory which they will illustrate in a final presentation.
This will support the students with the ability to work themselves into a topic based on literature research and to adequately present their knowledge. This is especially expected

	in the scope of the students' future research projects or in their professional carreer.
4	**Requirements for Participation** Recommended: DSP, general interest in signal processing
5	**Form of Examination** Module exam: • Module exam (Study achievement, Oral/written examination, Default RS) Report and/or Presentation and/or Colloquium. The type of examination will be announced in the beginning of the lecture.
6	**Requirements on the Award of Credit Points** Passing the exam
7	**Grading** Final Module Examination: • Module exam (Study achievement, Oral/written examination, Weighting: 100 %)
8	**Usability of the Module** MSc ETiT, MSc iST MSc iCE Wi-ETiT M.Sc. Synthetic Biology
9	**Literature** • Lecture slides • Jerry D. Gibson and James L. Melsa. Introduction to Nonparametric Detection with Applications. IEEE Press, 1996. • S. Kassam. Signal Detection in Non-Gaussian Noise. Springer Verlag, 1988. • S. Kay. Fundamentals of Statistical Signal Processing: Estimation Theory. Prentice Hall, 1993. • S. Kay. Fundamentals of Statistical Signal Processing: Detection Theory. Prentice Hall, 1998. • E. L. Lehmann. Testing Statistical Hypotheses. Springer Verlag, 2nd edition, 1997. • E. L. Lehmann and George Casella. Theory of Point Estimation. Springer Verlag, 2nd edition, 1999. • Leon-Garcia. Probability and Random Processes for Electrical Engineering. Addison Wesley, 2nd edition, 1994.

	• P. Peebles. Probability, Random Variables, and Random Signal Principles. McGraw-Hill, 3rd edition, 1993. • H. Vincent Poor. An Introduction to Signal Detection and Estimation. Springer Verlag, 2nd edition, 1994. • Louis L. Scharf. Statistical Signal Processing: Detection, Estimation, and Time Series Analysis. Pearson Education POD, 2002. • Harry L. Van Trees. Detection, Estimation, and Modulation Theory, volume I,II,III,IV. John Wiley & Sons, 2003. • A. M. Zoubir and D. R. Iskander. Bootstrap Techniques for Signal Processing. Cambridge University Press, May 2004.
10	**Comment**