

# MSc MBW – Master Molecular Biosciences

## List of courses offered in English if international students are enrolled

The duration of each course is 6 weeks, either in the 1<sup>st</sup> or 2<sup>nd</sup> half of the semester.

**Summer semester** (middle of April until middle of July)

- [MSc-Molbio-3 - Plant Biochemistry, 1<sup>st</sup> half of semester, 15 ECTS credits](#)
- [MSc-Molbio-6 - RNA Biology, 1<sup>st</sup> half of semester, 15 ECTS credits](#)
- [MSc-Molbio-9 - Biosynthesis of Natural Products, 2<sup>nd</sup> half of semester, 15 ECTS credits](#)
- [MSc-Molbio-9a - RNA Biology of Eukaryotes, 2<sup>nd</sup> half of semester, 15 ECTS credits](#)
- [MSc-Molbio-10 - Molecular Cell Biology and Biochemistry of Eukaryotic Systems, 2<sup>nd</sup> half of semester, 15 ECTS credits](#)

**Summer semester and Winter semester** (middle of October until middle of February of the following year)

- [MSc-Molbio-11 – Specialization, 1<sup>st</sup> and 2<sup>nd</sup> half of semester, 15 ECTS credits](#)

## Course descriptions

### MSc-Molbio-3 - Plant Biochemistry

15 ECTS credits (total) = 450 h, 13 SWS, Contact study 13 SWS / 195 h, Self-study 255 h.

#### Contents

The module comprises two lectures, a seminar, and a practical course. The lecture "Plant Biochemistry" covers the biochemistry of chloroplasts, metabolic fluxes and their regulation, and the bioenergetics of photosynthetic organisms. Plastidic transformation to gain transgenic plants will be explained and discussed. In the seminar, students will deepen their knowledge of these topics. The practical course focuses on methods in molecular biology and biochemistry, mainly to isolate and characterize membrane proteins. In addition, bio-physical methods, with a focus on spectroscopy, will be used. An additional lecture serves to broaden the knowledge beyond plant biochemistry.

#### Educational Objectives / Competences

By attending two lectures, students have acquired a broad and comparative view concerning the different fields of molecular biosciences. The students have gained knowledge about the complexity of regulation between different cellular compartments and are able to draw comparisons with other biological systems. Students possess practical skills in the field of plant biochemistry with special emphasis on isolation and characterization of membrane proteins and spectroscopic methods. Students have the ability to understand the theoretical background of the methods and to critically discuss their applicability to experimental problems. Through the seminar presentation, students have been trained in dealing directly with the original literature relevant to the topics and they are able to present scientific contents or their own results in English. Students thus can integrate knowledge and deal with complexity.

The students have furthermore become familiar with biosafety issues such as working in laboratories with S1 status according to the Genetic Engineering Act, know lab safety and environmental protection regulations and the rules of good scientific practice.

#### Requirements for Participation

Completed modules 1 or 2. For students of other master programs at least 15 CP must have been achieved before

#### Special notes

Students of this module must attend the lecture "Plant Biochemistry" and one other lecture from modules 4-6.

<b>Dates and Module Frequency</b>	Annually, in the summer semester
<b>Duration</b>	6 weeks in the first half of the semester
<b>Module responsible</b>	Prof. Dr. Büchel
<b>Proof of Study</b>	
<b>Proof of participation</b>	Proof of participation for the practical course and the seminar. Active participation in the seminar is proven by giving a presentation.
<b>Course Assessment</b>	For the practical course: Protocol
<b>Forms of Teaching</b>	Lecture, seminar, practical course, self-study
<b>Module Completion Test</b>	
<b>Module Completion Test consists of:</b>	60-minute written examination about the content of the two lectures. The grade of the module corresponds to the grade of this exam.

## MSc-Molbio-6 - RNA Biology, 1<sup>st</sup> half of semester

15 ECTS credits (total) = 450 h, 13 SWS, Contact study 13 SWS / 195 h, Self-study 255 h,

### Contents

The module teaches basics of function and structure of ribonucleic acids and includes lecture, seminar, and practical course. Main contents of the lecture are: Chemical structure and conformation of RNA building blocks; Secondary and tertiary structure of RNA; Regulatory RNA elements in prokaryotes; RNA based mechanisms in eukaryotes; Structure and function of RNA based molecular machines using the example of the ribosome and spliceosome. The lab course covers the following main topics: Enzymatic synthesis of RNA; Isolation of functional RNAs from microorganisms; Biochemical, biophysical, and spectroscopic methods for characterization of RNA-ligand and RNA-protein interactions. An additional lecture is designed to broaden the subject knowledge beyond RNA biology.

### Educational Objectives / Competences

Upon completion of the module, students will have an in-depth knowledge of the role of functional RNAs in several fundamental regulatory processes and their structural basis. The seminar presentation will also provide practice in dealing with the primary literature relevant to the topics and in presenting scientific content in English, as well as in presenting their own results in a scientific context. Students are thus able to integrate knowledge and deal with complexity.

The students are further familiar with biosafety issues such as working in laboratories with S1 status according to the Genetic Engineering Act, are familiar with occupational safety and environmental protection regulations and the rules of good scientific practice.

### Requirements for Participation

Completed modules 1 or 2. For students of other master programs at least 15 CP must have been achieved before.

### Special notes

Students of this module must attend the lecture "RNA Biology" and one other from modules 3-5.

<b>Dates and Module Frequency</b>	Annual in summer semester
<b>Duration</b>	6 weeks in the first half of the semester
<b>Module responsible</b>	Prof. Dr. Wöhhert
<b>Proof of Study</b>	
<b>Proof of participation</b>	Proof of participation for internship and seminar. The active participation in the seminar is proven by the presentation of a lecture.
<b>Course Assessment</b>	For the practical course: Protocols
<b>Forms of Teaching</b>	Lecture, seminar, practical course, self-study
<b>Module Completion Test</b>	
<b>Module Completion Test consists of:</b>	60-minute written examination about the content of the two lectures. The grade of the module corresponds to the grade of this exam.

## MSc-Molbio-9 - Biosynthesis of Natural Products, 2<sup>nd</sup> half of semester

15 ECTS credits (total) = 450 h, 13 SWS, Contact study 13 SWS / 195 h, Self-study 255 h,

### Contents

The module includes lecture, seminar, and practical course. In this module, students receive a functional overview of secondary metabolites. Emphasis is placed on the biosynthetic pathways leading to polyketides and peptides, but also to other classes of natural products (alkaloids, terpenes, phenylpropanoids). Typical reaction sequences will be discussed in an exemplary way. Further contents are gene cloning and genetic metabolic modifications in different organisms. In the practical part, mainly analytical methods for end product, and metabolite identification are used, measurements are performed after physiological modulation of biosynthetic pathways. In the seminar an in-depth insight into current research on natural product biosynthesis is given.

### Learning outcomes / competence goals

Acquisition of knowledge about secondary metabolites, their function and biochemical assignment; understanding of the structure of biosynthetic pathways and the sequence of partial reactions, teaching of basic analytical methods and laboratory techniques for metabolite detection. Seminar presentation will provide practice in the use of primary literature and presentation skills. Students are thus able to integrate knowledge and deal with complexity.

The students are further familiar with biosafety issues such as working in laboratories with S1 status according to the Genetic Engineering Act, are familiar with occupational safety and environmental protection regulations and the rules of good scientific practice.

### Participation requirements for module or for individual courses of the module.

Completed modules 1 or 2. For students of other master programs at least 15 CP must have been achieved before.

### Special notes

Students of this module must attend the lecture "Biosynthesis of Natural Products" and another one from modules 7, 8, 9a or 10.

<b>Dates and Module Frequency</b>	Annual in summer semester
<b>Duration</b>	6 weeks in the second half of the semester
<b>Module responsible</b>	Prof. Dr. Helfrich
<b>Proof of Study</b>	
<b>Proof of participation</b>	Proof of participation for internship and seminar. The active participation in the seminar is proven by the presentation of a lecture.
<b>Course Assessment</b>	For the practical course: Protocols
<b>Forms of Teaching</b>	Lecture, seminar, practical course, self-study
<b>Module Completion Test</b>	
<b>Module Completion Test consists of:</b>	60-minute written examination about the content of the two lectures. The grade of the module corresponds to the grade of this exam.

## MSc-Molbio-9a - RNA Biology of Eukaryotes, 2<sup>nd</sup> half of semester

15 ECTS credits (total) = 450 h, 13 SWS, Contact study 13 SWS / 195 h, Self-study 255 h,

### Contents

The module comprises lecture, seminar and practical course and teaches the versatile structures and functions of ribonucleic acids (RNAs) and RNA-protein complexes (RNPs) in eukaryotes. Major contents of the lecture are regulatory RNAs and RNA elements in eukaryotes, processing, and stability of mRNAs, editing and modification of RNAs, structure and function of RNPs, diversity and specificity of RNA binding proteins (RBPs) and methods to study RNPs. The following experiments will be discussed and performed in the lab:

Part A) Recombinant preparation and purification of a eukaryotic RBP, enzymatic synthesis of a target RNA, biochemical and spectroscopic characterization of the RNP. Part B) Expression of the same RBP with a fluorescent tag in human cells. Staining of a target RNA in cells by RNA FISH. Biochemical and microscopic characterization of the RNP in human cells.

### Learning Outcomes / Competence Goals

Upon completion of the module, students will have increased their knowledge of the diversity, structure, and function of regulatory RNAs and RNA elements in eukaryotic systems. In addition, they will have learned about various RNA-based regulatory mechanisms and covered the functions of RBPs and the structure of RNPs in the context of post-transcriptional gene regulation. In the literature seminars, they will present recent publications on RNPs in English; in the lab seminars, they will present their results from the lab and discuss them with fellow students. This will provide practice in using primary literature, presenting scientific content in English, and communicating/discussing their own findings. Students will further become familiar with issues of genetic safety and working in the S1 laboratory, occupational health and safety, and the rules of good scientific practice.

### Participation requirements for module or for individual courses of the module

Completed module MSc-Molbio-1 or Molbio-2. Students of other Master's programs must have previously completed at least 15 CP; good knowledge of English.

### Recommended prerequisites/special notes

It is recommended to have listened to the lecture 'RNA Biology of Prokaryotes' in module 6 and ideally to have taken the Module 6. Here the basics of RNA biology are taught, on which module 9a builds.

### Special notes

Students in this module must take the lecture 'RNA Biology of Eukaryotes' and one other lecture from modules 7-10.

<b>Dates and Module Frequency</b>	Annual in summer semester
<b>Duration</b>	6 weeks in the second half of the semester
<b>Module responsible</b>	Prof. Dr. Müller-McNicoll, Dr. Andreas Schlundt
<b>Proof of Study</b>	
<b>Proof of participation</b>	Proof of participation for internship and seminar. The active participation in the seminar is proven by the presentation of a lecture.
<b>Course Assessment</b>	For the practical course: Protocols, lab seminar
<b>Forms of Teaching</b>	Lecture, seminar, practical course, self-study
<b>Module Completion Test</b>	
<b>Module Completion Test consists of:</b>	60-minute written examination about the content of the two lectures. The grade of the module corresponds to the grade of this exam.

## MSc-Molbio-10 - Molecular Cell Biology and Biochemistry of Eukaryotic Systems, 2<sup>nd</sup> half of semester

15 ECTS credits (total) = 450 h, 13 SWS, Contact study 13 SWS / 195 h, Self-study 255 h,

### Contents

The module comprises lecture, seminar, and practical course as an in-depth combination of theoretical transfer of factual knowledge and practical implementation. The courses include cell biology of higher eukaryotes with focus on intracellular mass transport and membrane biology, as well as cellular biochemistry of eukaryotes using mammalian cells, yeasts, and plants as examples. Special emphasis is given to signal transport and its specificities in different systems, protein transport in cells from synthesis to degradation, fluxes of substances in the cell and across the membrane, and organelle and protein complex dynamics. An additional lecture is designed to broaden the student's expertise beyond molecular cell biology and biochemistry of eukaryotic systems.

### Learning Outcomes / Competence Goals

Upon completion of the module, students will have a broad base in the field of molecular cell biology and biochemistry on complementary eukaryotic systems and will be familiar with the basic practical methods of cell biology and biochemistry. Through seminar presentation, students will also be proficient in the use of primary literature and English-language presentation of scientific content. Students will thus be able to integrate knowledge and deal with complexity.

The students are furthermore familiar with biosafety issues such as working in laboratories with S1 status according to the Genetic Engineering Act, are familiar with occupational safety and environmental protection regulations and the rules of good scientific practice.

### Participation requirements for module or for individual courses of the module.

Completed modules 1 or 2. For students of other master programs at least 15 CP must have been achieved before.

### Special notes

Students of this module must attend the lecture "Principles of Molecular Cell Biology and Biochemistry of Eukaryotic Systems Using Transport Processes as an Example" and one additional lecture from modules 7-9.

<b>Dates and Module Frequency</b>	Annual in summer semester
<b>Duration</b>	6 weeks in the second half of the semester
<b>Module responsible</b>	Dr. Fragkostefanakis
<b>Proof of Study</b>	
<b>Proof of participation</b>	Proof of participation for internship and seminar. The active participation in the seminar is proven by the presentation of a lecture.
<b>Course Assessment</b>	For the practical course: Protocols, lab seminar
<b>Forms of Teaching</b>	Lecture, seminar, practical course, self-study
<b>Module Completion Test</b>	
<b>Module Completion Test consists of:</b>	60-minute written examination about the content of the two lectures. The grade of the module corresponds to the grade of this exam.

## MSc-Molbio-11 – Specialization, 1<sup>st</sup> and 2<sup>nd</sup> half of semester

15 ECTS credits (total) = 450 h, 13 SWS, Contact study 13 SWS / 195 h, Self-study 255 h,

### Contents

The module comprises seminar and laboratory practical in a working group of choice as an in-depth combination of independent familiarization with a subject area and practical implementation. The students choose the course from the catalog of offered practical courses (announcement at the end of the previous semester) independently of the master thesis.

### Learning outcomes / competence goals

The specialization module teaches students the scientific working methods of designing, performing, and presenting experiments. Upon completion of the module, students will have a good basis for independent familiarization with a special field and will have learned to apply this theoretical knowledge practically.

Students will further be familiar with biosafety issues such as working in laboratories with S1 status under the Genetic Engineering Act, know occupational safety and environmental protection regulations and the rules of good scientific practice.

### Participation requirements for module or for individual courses of the module

Successful completion of modules 1 and 2 as well as one module from modules 3-10.

<b>Dates and Module Frequency</b>	Annual in summer and winter semester
<b>Duration</b>	6 weeks
<b>Proof of Study</b>	
<b>Proof of participation</b>	Proof of participation for internship and seminar. The active participation in the seminar is proven by the presentation of a lecture.
<b>Course Assessment</b>	For the practical course: Protocols, lab seminar
<b>Forms of Teaching</b>	Lecture, seminar, practical course, self-study
<b>Module Completion Test</b>	
<b>Module Completion Test consists of:</b>	Oral exam of 20-30 min on the content and theoretical background of the internship.