2016

MATHEMATISCH-
NATURWISSENSCHAFTLICHE
FAKULTÄT

UNIVERSITÄT ZU KÖLN

DEKANAT

MODULE COMPENDIUM

BIOCHEMISTRY - DRAFT

1-FACH-MASTER OF SCIENCE

VERSION 1.4

ACCORDING TO THE EXAMINATION REGULATIONS FOR THE 1-FACH-MASTER OF SCIENCE IN BIOCHEMISTRY

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Universität zu Köln

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Abbreviations

CP	Credit Points
CT	Contact Times
h	Hours
SST	Self Study Times
ST	Summer Term
WT	Winter Term

Contents

1 The Master´s Degree Course Biochemistry

1.1 Content, Aims of Studies and Requirements

The Master of Science in Biochemistry program is research-oriented and taught in English. The successful completion of the two years program will lead to the award of the Master of Science (M.Sc.) degree. With the program students will acquire a strong background in basic biochemistry and in modern life science research practice, which will fit them well for many careers in both academic and applied environments. The modules are allocated to the main life science areas, i.e. biochemical, biomolecular and medical molecular research. Thus students can both extend and specialize their biochemical knowledge.

Requirements to participate in the Master´s Degree Course Biochemistry are specified in the appendix of the examination regulations.

1.2 Structure and Progression of the Course of Studies

In the first year of the program students choose three Subject Modules of their preference, thereof two have to be in biochemistry and one can be general. In addition, students conduct one Laboratory Module in a research group of choice and the Advanced Module “Scientific Writing”. The second year of the program is dedicated to research. It includes another Laboratory Module and the Project Proposal Module, where questions, concepts and methods applied in the Master project are delineated. The program is completed by a six-months research project that will be written up in a Master’s thesis and presented in a colloquium (Master Thesis & Defense Module).

1.3 General CP-Survey

See also 1.4 for more detailed information

General CP-Survey	
Professional Studies	**84 CP**
Master Module	**36 CP**
Total	**120 CP**

1.4 Term Based Course Schedule

Course Schedule			
Term	**Advanced Modules**	**Specialization Modules**	**Total CP**
1	**Subject Module* I** (1st half of the term, 12 CP) **Subject Module* II** (2nd half of the term, 12 CP) **Scientific Writing Module** (non-term, 6 CP)		30
2	**Subject Module* III** (1st half of the term, 12 CP)	**Laboratory Module I**** (2nd half of the term, 18 CP)	30
3		**Laboratory Module II**** (1st half of the term, 18 CP) **Project Proposal Module** (2nd half of the term, 6 CP)	24
4		**Master Thesis & Defense Module** (36 CP)	36

* Two modules have to be in biochemistry, one can be in a general subject
** The Laboratory Modules have to be performed in different research groups.

1.5 Calculation of the Overall Grade

Each of the three Subject and the two Laboratory Modules accounts for 10 % of the overall grade, the Scientific Writing and Project Proposal Module account each with 5 %, and the Master Thesis & Defense Module accounts for 40 % of the overall grade.

2 Module Descriptions

The study program contains eight modules. They are distinguished in Advanced Modules, Specialization Modules, and the Master Thesis & Defense Module.

Students have to successfully complete three scientific subject modules (= **Advanced Modules**), preferably in the first and second term of the Master´s degree course. Two subject modules have to be chosen in the field of biochemistry (Table 1a), one can be located in a related ("general") scientific life science or natural science field (see Table 1b). The fourth Advanced Module (MN-BC-SW) contains "Scientific Writing" (Table 1c) and aims to train a necessary soft skill. The subject modules aim to extend the knowledge in the respective research area, while simultaneously extending the skills of presenting scientific results in oral and written form. To control for the acquirement of these different competences, each module contains two to three different examination elements.

The Laboratory Modules (= **Specialization Modules**) (Table 2) in the second and third term of the Master´s degree course will help students to learn how to actively integrate into a research group and train and extend their practical work skills. Please note, that a student may not do both Laboratory Modules in one research group. Furthermore, the students will be trained in the module "Project Proposal" to design, conduct and present scientific projects independently so that they will be well prepared for the realization of the module "Master Thesis & Defense". Preparation times before the official start of a Specialization Module are not included in the respective module description as they may vary due to different demands in the respective research area.

The Master Thesis is an integrative part of the module "Master Thesis & Defense". Further information and regulations can be found in the respective module description as well as in the examination regulations of the Master´s degree course.

Ahead of the detailed module descriptions an overview of the available modules is presented below and sorted according to the two main module areas. The following module descriptions have been listed in chronological order according to their identification number.

Concerning contact and self-study times all decimal numbers were rounded. The values correspond to the effective contact times over the total duration of the module (including examination times; preparation times before the official start of the module are not included). Contact times may differ slightly due to different demands in the respective research area.

Table 1a: Advanced Modules: Biochemical Subject Modules (BSM)

Identification Number	**Name**	**Rotation**	**Module Examination Type***	
MN-BC-BSM-01	Medical Biochemistry: Enzymes, Metabolites and Diseases	WT 1st half	1	elective module
MN-BC-BSM-02	Introduction to Bioinformatics	WT 1st half	1	elective module
MN-BC-BSM-03	Protein Trafficking in the Endomembrane System	WT 1st half	1	elective module
MN-BC-BSM-04	Structural Biology I: Protein Crystallography	WT 2nd half	2	elective module
MN-BC-BSM-05	Molecular Plant Physiology and Biochemistry of Plants and Associated Microbes	Each term, 2nd half	1	elective module
MN-BC-BSM-06	Structural Biology II: Analysis of Protein Structures and Protein-Protein Interactions	ST 1st half	2	elective module
MN-BC-BSM-07	Redoxbiochemistry	ST 2nd half	1	elective module
MN-BC-BSM-08	Mitochondria and Neurodegeneration	ST 1st half	1	elective module
MN-BC-BSM-09	Peptide Biochemistry	ST 2nd half	1	elective module
MN-BC-BSM-10	Neurobiochemistry	ST 1st half	1	elective module
MN-BC-BSM-11	Molecular Medicine – Molecular and Cellular Mechanisms in the Pathogenesis of Human Diseases	WT 1st half	1	elective module

Table 1b: Advanced Modules: General Subject Modules (GSM)

Identification Number	**Name**	**Rotation**	**Module Examination Type***	
MN-BC-GSM-01	Model Systems of Aging and Age-related Diseases	WT 1st half	2	elective module
MN-BC-GSM-02	Plant Genetics	Each term, 1st half	1	elective module
MN-BC-GSM-03	Analysis of High-Dimensional (-omics) Data	WT 2nd half	1	elective module
MN-BC-GSM-04	Modern Techniques of Developmental Biology	Each term, 2nd half	1	elective module

MN-BC-GSM-05	Molecular Genetics	WT 2nd half	2	elective module
MN-BC-GSM-06	Advanced Light Microscopy	ST 2nd half	1	elective module
MN-BC-GSM-07	Population Genetics and Molecular Evolution	ST 2nd half	1	elective module
MN-BC-GSM-08	Advanced Bioinformatics	ST 2nd half	1	elective module
MN-BC-GSM-09	Mouse Genetics, Cell Death and Inflammation	ST 2nd half	2	elective module
MN-BC-GSM-10	Advanced Chemistry	Whole term	2	elective module
MN-BC-GSM-11	Functional Genomics	WT 2nd half	2	elective module
MN-BC-GSM-12	Microbial Genetics	WT 1st half	1	elective module
MN-BC-GSM-13	Methods and Techniques in Chemical Ecology	ST 1st half	2	elective module

Table 1c: Advanced Module: Scientific Writing

Identification Number	**Name**	**Rotation**	**Module Examination Type***	
MN-BC-SW	Scientific Writing	non-term	3	compulsory module

Table 2: Specialization Modules

Identification Number	**Name**	**Rotation**	**Module Examination Type***	
MN-BC-LM1	Laboratory Module 1	year-round	2	compulsory module
MN-BC-LM2	Laboratory Module 2	year-round	2	compulsory module
MN-BC-PP	Project proposal	year-round	3	compulsory module
MN-BC-MT	Master Thesis & Defense	year-round	2	compulsory module

* Examination type is defined by the number of examination elements. Type 1 comprises three elements, type 2 two elements, type 3 one element. The proportional weighting of the individual elements for the total module grade is outlined in the module descriptions (No. 6).

2.1 Advanced Modules: Biochemical Subject Modules

<table>
<tr><td colspan="6">Medical Biochemistry: Enzymes, Metabolites and Diseases</td></tr>
<tr><td colspan="2">Identification number
MN-BC-BSM-01</td><td>Workload
360 h</td><td>Credit points
12 CP</td><td>Term of studying
1st or 2nd term of studying</td><td>Frequency of occurrence
Winter term, 1st half</td><td>Duration
7 weeks</td></tr>
<tr><td>1</td><td colspan="2">Type of lessons
a) Lectures
b) Practical/Lab
c) Seminar</td><td>Contact times
24 h
154 h
8 h</td><td>Self-study times
48 h
102 h
24 h</td><td>Intended group size*
max. 20
max. 2
max. 5</td></tr>
<tr><td>2</td><td colspan="6">Aims of the module and acquired skills
Students who successfully completed this module …
• have acquired detailed knowledge on biosynthesis of cofactors and coenzymes, their relation to basic metabolism of nucleotides and amino acids and are enabled to recognize common themes in enzymatic catalysis and metabolic networks. In particular, disorders and treatments of inborn errors in metabolism are understood and can be connected to basic biochemical problems.
• can independently develop strategies for protein purification and characterization and are able to analyze enzymes on different levels, such as primary sequence, domain structure, oligomerization and three-dimensional structure.
• can determine enzyme activities, describe their reaction mechanism and uncover the action of different types of inhibitors.
• can independently carry out small scientific projects related to the topic of the module.
• have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
• are able to transfer skills acquired in this module to other fields of biochemistry</td></tr>
<tr><td>3</td><td colspan="6">Contents of the module
• Protein purification using column chromatography
• Biophysical, biochemical and structural analysis of proteins (spectroscopy, mass spectrometry, size exclusion, electrophoresis, determination of domain structure)
• Recombinant protein expression (His-tagged, intein-tagged, GST-tagged)
• Enzyme kinetics including inhibition, regulation, electron transfer (spectroscopy, HPLC, stopped-flow)
• Assembly of protein complexes and determination of protein-interaction (isothermal titration calorimetry, differential scanning calorimetry, surface plasmon resonance, co-sedimentation)
• HPLC analysis of metabolites in urine and blood
• Maturation of enzymes, cellular localization
• Screening for inhibitors
• Viability of cells (neurons, fibroblast)
• Biogenesis of cofactors and coenzymes</td></tr>
</table>

* 8 students from the Master´s degree course “Biochemistry”, 8 students from the Master’s degree course “Biological Sciences” and 4 students from the Master´s degree course “Chemistry”.

Medical Biochemistry – Enzymes, Metabolites and Diseases (MN-BC-BSM-01) continued

	• Nucleotide and amino acid metabolism • Inborn errors in metabolism • Drug development
4	**Teaching/Learning methods** Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form
5	**Requirements for participation** Enrollment in the Master´s degree course “Biochemistry”, in the Master’s degree course “Biological Sciences” or in the Master´s degree course “Chemistry”
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least “sufficient” (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master’s degree course “Biological Sciences”; combined advanced and experimental module in the Master´s degree course “Chemistry”
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master’s degree course “Biochemistry” (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Günter Schwarz, phone 470-6440, e-mail: gschwarz@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course “Biochemistry” **Literature:** • Berg, J.M., Tymoczko, J.L., Stryer, L. (2012) Biochemistry. 7th edition, Springer Spektrum • Voet, D., Voet, J.G. (2011) Biochemistry. 4th edition, Wiley & Sons • Frey, P.A., Hegemann, A.D. (2007) Enzymatic Reaction Mechanisms. Oxford University Press • Additional subject-specific literature will be provided at the beginning of the module **Note:** The module contains hand-on laboratory work conducted by small groups of students and is taught in course rooms and research laboratories. The module does not contain computer-based research as a main component. **General time schedule:** Weeks 1-5 (Mon.-Fri.): Lectures, practical/lab, preparation for the seminar talk (topic and date will be arranged individually); Week 6 (Mon.-Fri.): Writing seminar paper; Week 7 (Mon.-Fri.): Preparation for the written examination **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

<table>
<tr><td colspan="7">Introduction to Bioinformatics</td></tr>
<tr><td colspan="2">Identification number
MN-BC-BSM-02</td><td>Workload
360 h</td><td>Credit points
12 CP</td><td colspan="2">Term of studying
1st or 2nd term of studying</td><td>Frequency of occurrence
Winter term, 1st half</td><td>Duration
7 weeks</td></tr>
<tr><td>1</td><td colspan="2">Type of lessons
a) Lectures
b) Practical/Lab
c) Seminar</td><td colspan="2">Contact times
36 h
84 h
12 h</td><td>Self-study times
72 h
140 h
24 h</td><td colspan="2">Intended group size*
max. 12
max. 6
max. 6</td></tr>
<tr><td>2</td><td colspan="7">Aims of the module and acquired skills
Students who successfully completed this module …
• have acquired detailed knowledge about the fundamentals of bioinformatics and are able to perform simple bioinformatical analyses and related tasks on personal computers running the Linux operating system.
• have become familiar with common bioinformatical algorithms, computational sequence analysis, knowledge extraction from biological databases, and the statistical evaluation of bioinformatical results.
• know what kind of biological problems can be solved by bioinformatical tools, can choose appropriate methods and judge the statistical and biological significance of the results.
• can independently carry out small scientific projects related to the topic of the module.
• have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
• are able to transfer skills acquired in this module to other fields of biochemistry.</td></tr>
<tr><td>3</td><td colspan="7">Contents of the module
• Computer operating system Linux
• Programming with shell scripts and the statistical programming language R
• Algorithms in bioinformatics
• Sequence comparison and alignment
• Biological databases (sequence databases, genome databases, functional databases)
• Prediction of protein architecture (structure, domains, motifs, disorder)
• Evolutionary processes acting on sequences (expansion, shuffling, conversion, neofunctionalization)
• Protein sequence analysis, domain detection, motif detection
• Bioinformatical prediction of sequence function, localization, interaction, structure, etc.
• Gene expression analysis (microarrays, RNA-Seq)
• Essential statistics (distributions, tests, correlation)</td></tr>
</table>

* 2 students from the Master´s degree course “Biochemistry” and 10 students from the Master’s degree course “Biological Sciences”.

Introduction to Bioinformatics (MN-BC-BSM-02) continued

4	**Teaching/Learning methods** Lectures; Practical/Lab (Project work); Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form
5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry" or in the Master's degree course "Biological Sciences" **Additionally recommended:** Entry-level programming skills are necessary to participate in this module. In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Thomas Wiehe, phone 470-1588, e-mail: twiehe@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Reviews and original papers will be handed out during the module **General time schedule:** Weeks 1-6: Lectures (Mon., Wed., Fri. 2 h each), practical/lab (Mon. 2 h, Tue. 4 h, Wed. 2 h, Thu. 4 h, Fri. 2 h), seminars (Thu. 2 h), writing seminar paper and preparation for the seminar talk (topic and date will be arranged individually); Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module contains hand-on computer work conducted individually and is taught in a computer course room. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Protein Trafficking in the Endomembrane System					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-BSM-03	360 h	12 CP	1st or 2nd term of studying	Winter term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	16 h	32 h	max. 6
	b) Practical/Lab	155 h	129 h	max. 1
	c) Seminar	4 h	24 h	max. 2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge about the major protein trafficking pathways in eukaryotic cells, molecular factors of intracellular sorting machineries and their interplay with membrane lipids and the cytoskeleton.
- have acquired experimental skills in state-of-the art methods of cell biology, biochemistry and biophysics and can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Intracellular trafficking routes and their regulation in different model organisms (human, mouse, yeast, plants)
- Analysis of post-translationally modified proteins, SDS-PAGE electrophoresis and Western blotting
- Protein purification using column chromatography
- Recombinant protein expression
- Synthesis and analysis of membrane-active peptides
- Analysis of protein-protein, protein-lipid and peptide/lipid interactions
- Surface Plasmon resonance
- Gene knockdown
- Isolation of primary cells from transgenic animals
- Culture and transfection of animal, human and plant cells
- Cell-viability assays
- Separation and purification of membrane compartments by differential centrifugation
- Site-directed mutagenesis
- Inducible expression systems
- Laser confocal scanning microscopy

Explanatory note The above list comprises techniques used in the participating groups in the context of this module. The exact content for each student will depend on the research project.

* 1 student from the Master´s degree course “Biochemistry” and 5 students from the Master’s degree course “Biological Sciences”.

Protein Trafficking in the Endomembrane System (MN-BC-BSM-03) continued

4	**Teaching/Learning methods** Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form
5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry" or in the Master's degree course "Biological Sciences"
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Stefan Höning, phone 478-3656, e-mail: shoening@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Alberts, B., Bray, D., Lewis, J. (2008) Molecular Biology of the Cell. 5th edition, Taylor & Francis • Lodish, H., Berk, A., Kaiser, C.A. *et al.* (2007) Molecular Cell Biology. 6th edition, Palgrave Macmillan **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures, practical/lab, writing seminar paper and preparation for the seminar talk (held at the end of week 6); Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted individually and is taught in research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Structural Biology I: Protein Crystallography					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-BSM-04	360 h	12 CP	1st or 2nd term of studying	Winter term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	24 h	48 h	max. 14
	b) Practical/Lab	151 h	108 h	max. 14
	c) Seminar	5 h	24 h	max. 14

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired a thorough knowledge of the principles of macromolecular crystallography as one of the most important methods as well as of the theory of crystallography and X-ray diffraction.
- Are able to analyze diffraction data and solve macromolecular crystal structures
- are familiar with different methods for 3D structure determination and can compare them with respect to their results and limits.
- are able to set up crystallization screens, analyze crystals by X-ray diffraction and determine crystal structures by the application of the relevant computer programs.
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer the skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Crystallographic foundations: crystal geometry, symmetries
- Theory of X-ray diffraction
- Crystallization experiments
- Crystallographic data collection and analysis
- Approaches for solving the phase problem
- Structure building and refinement
- Quality assessment

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry”, in the Master’s degree course “Biological Sciences” or in the Master´s degree course “Chemistry”

* 4 students from the Master´s degree course “Biochemistry”, 6 students from the Master’s degree course “Biological Sciences” and 4 students from the Master´s degree course “Chemistry”.

Structural Biology I: Protein Crystallography (MN-BC-BSM-04) continued

6	**Type of module examinations** The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (70 % of the total module mark) and oral presentation (30 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master's degree course "Biological Sciences", combined advanced and experimental module in the Master's degree course "Chemistry"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Ulrich Baumann, phone 470-3208, e-mail: ubaumann@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master's degree course "Biochemistry" **Literature:** • Rupp, B. (2010) Biomolecular Crystallography. Garland Science • Blow, D. (2002) Outline of Protein Crystallography for Biologists. Oxford University Press • Branden, C.I., Tooze, J. (1998) Introduction to Protein Structure. 2nd edition, Taylor and Francis • Liljas, A., Liljas, L., Piskur, J., Lindblom, G., Nissen, P., Kjeldgaard, M. (2009) Textbook on Structural Biology. World Scientific • Additional material and subject specific literature will be provided *ad hoc* **Note:** The module contains hand-on laboratory work conducted by small groups of students and is taught in course rooms and research laboratories. The module contains computer-based practicals/ research as a main component. **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures at 8:30-10:00 a.m. (three times a week), following experimental/computational work till 5 p.m. (including lunch break, the exact times of lectures and practical work can vary according to the laboratory needs); Week 6 (Mon.-Fri.): Preparation and presentation of seminar talk; Week 7 (Mon.-Fri.): Preparation for the written examination **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Molecular Plant Physiology and Biochemistry of Plants and Associated Microbes					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-BSM-05	360 h	12 CP	1st or 2nd term of studying	each term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Tutorials	22 h	33 h	max. 2
	b) Practical/Lab	161 h	117 h	max. 2
	c) Seminar	3 h	24 h	max. 2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge about methods used in plant DNA technology and protein biochemistry as well as knowledge of principles and methods used in molecular plant physiology.
- are trained in the use of transgenic approaches and methods to functionally analyze gene products and their impact on plant growth and development (see contents of the module).
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Identification and screening of T-DNA insertion lines (primer design, PCR, gDNA)
- Generation of transgenic plants and fungi
- Pathogenicity assays
- Generation of RNAi or artificial micro-RNA constructs
- Detection of reporter gene activity
- Localization studies of transgenic products
- Comparative characterization of mutant lines
- Metabolite profiling
- DNA-protein interaction studies
- Protein-protein interaction studies (co-immunoprecipitation, yeast two hybrid, split YFP)
- Nutrient transport studies
- Production of recombinant protein in *E. coli*
- Photosynthesis measurements by modulated Chl fluorescence

Explanatory note: The list above comprises state-of-the art biochemical and molecular methods with emphasis on DNA technologies and protein biochemistry that are commonly used in the field of molecular plant physiology. Every student participating in this module will be confronted with a large subset of it. The exact content, however, will depend on the 4.5-week research project the student will work on (lab of Prof. Dr. M. Bucher: plant-microbe interactions, transporters, and plant metabolism, lab of Prof. Dr. G. Döhlemann: plant immunity and microbial virulence, lab of Prof. Dr. U. Höcker: light signaling and developmental biology, lab of Prof. Dr. S. Kopriva: plant mineral nutrition).

* The module is conceived for a total of up to 8 students: 1 student from the Master´s degree course "Biochemistry" and 7 students from the Master's degree course "Biological Sciences".

Molecular Plant Physiology and Biochemistry of Plants and Associated Microbes (MN-BC-BSM-05) continued

4	**Teaching/Learning methods** Interactive tutorials; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form
5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry" or in the Master's degree course "Biological Sciences" **Additionally recommended:** Successful participation in an advanced Molecular Plant Physiology and Biochemistry module during the Bachelor´s degree course (e.g. MN-B-WP II [mPlant 1] for Cologne students) or similar skills (after consultation). In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the tutorials and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master's degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Marcel Bucher, phone 470-2481, e-mail: m.bucher@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Heldt, H.-W., Piechulla, B. (2008) Plant Biochemistry. 4rd edition, Academic Press • Buchanan, B.B., Gruissem, W., Jones, R.J. (2002) Biochemistry and Molecular Biology of Plants. Wiley & Sons • For those students, who speak German: Kapitel 5 (Stoffwechselphysiologie) aus Bresinsky, A., Körner, C., Kadereit, J.W. *et al.* (2008) Strasburger - Lehrbuch der Botanik. 36. Auflage, Spektrum Akademischer Verlag • Further original papers will be handed out during the module. **General time schedule:** Week 1-4 (Mon.-Fri.) and Week 5 (Mon.-Wed): Tutorials and practical/lab; Week 5 (Thu-Fri) and Week 6 (Mon.-Fri): Preparation for the seminar talk (held at the end of week 6) as well as writing seminar paper; Week 7 (Mon.-Fri): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted individually and is taught in research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Structural Biology II: Analysis of Protein Structures and Protein-Protein Interactions					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-BSM-06	360 h	12 CP	1st or 2nd term of studying	Summer term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	23 h	46 h	max. 12
	b) Practical/Lab	151 h	108 h	max. 2
	c) Seminar	8 h	24 h	max. 6

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge on the principles of protein structures and their meaning as well as of structure-function relationships for various protein classes.
- have acquired working skills in recombinant purification of proteins in mg amounts.
- have an overview of biophysical techniques to characterize purified proteins and protein-protein interactions.
- Have acquired expertise in the use of computer graphics programs to visualize and analyse protein structures.
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Principles of protein structures
- Proteolytic enzymes
- Foundations of macromolecular X-ray crystallography
- Recombinant protein expression in *Escherichia coli*
- Recombinant protein purification using column chromatography
- Protein crystallisation and overview of crystal structure analysis
- Biophysical and biochemical analysis of expressed proteins including activity and inhibition assays
- Use of data bases for primary and tertiary protein structure analysis, display programs
- Protein crystallography: some introductory material

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form

***** 6 students from the Master´s degree course “Biochemistry”, 4 students from the Master’s degree course “Biological Sciences” and 2 students from the Master´s degree course “Chemistry”.

Structural Biology II: Analysis of Protein Structures and Protein-Protein Interactions (MN-BC-BSM-06) continued

5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry", in the Master's degree course "Biological Sciences" or in the Master´s degree course "Chemistry"
6	**Type of module examinations** The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (some of the questions have to be answered using computer programs; 70 % of the total module mark), oral presentation (30 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master's degree course "Biological Sciences", combined advanced and experimental module in the Master's degree course "Chemistry"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Ulrich Baumann, phone 470-3208, e-mail: ubaumann@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Branden, C.I., Tooze, J. (1998) Introduction to Protein Structure. 2nd edition, Taylor and Francis • Liljas, A., Liljas, L., Piskur, J., Lindblom, G., Nissen, P., Kjeldgaard, M. (2009) Textbook on Structural Biology. World Scientific • Blow, D. (2002) Outline of Protein Crystallography for Biologists. Oxford University Press • Garrett, R.H., Grisham, C.M. (2008) Biochemistry. 4th edition, Brooks/Cole (or similar textbook) • Petsko, G., Ringe, D. (2004) Protein Structure and Function. New Science Press (www.new-science-press.com/browse/protein). • Specific programs: *PyMOL* (www.ebi.ac.uk/~gareth/pymol/); *Chimera* (www.cgl.ucsf.edu/chimera/) • Additional material and subject specific literature will be provided *ad hoc* **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures (8.30-10 a.m., three times a week) and practical/lab (till 5 p.m. including lunch break, the exact times may vary according to laboratory needs); Week 6 (Mon.-Fri.): Writing seminar paper and preparation for the seminar talk (held at the end of week 6); Week 7 (Mon.-Fri.): Preparation for the written examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html)

Redoxbiochemistry					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurence**	**Duration**
MN-BC-BSM-07	360 h	12 CP	1st or 2nd term of studying	Summer term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	24 h	48 h	max. 10
	b) Practical/Lab	154 h	102 h	max. 10
	c) Seminar	8 h	24 h	max. 10

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge on biosynthesis and regulation of mitochondrial proteins, and on redox-dependent processes in diverse organelles and organisms.
- can independently develop strategies for characterization of different enzymes and pathways, and are able to analyze enzymes/pathways on different levels, such as primary sequence, domain structure, oligomerization, three-dimensional structure, evolutionary conservation, genetic interactions with other pathways.
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biology.

3 Contents of the module

- Yeast cell culture, analyses of yeast phenotypes and genetic manipulation
- Purification of recombinant proteins and their biophysical, biochemical and structural analysis.
- Enzyme kinetics on redox enzymes
- Genetically-encoded fluorescent sensors (H_2O_2, glutathione, ATP, pH)

4 Teaching/Learning methods

- Lectures; Practical/Lab (Project work, mainly in groups of 2); Seminar; Guidance to independent research (experiment planning, analyses and trouble shooting); Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry”, or in the Master’s degree course “Biological Sciences”

Additionally: Successful participation in an advanced Biochemistry module during the Bachelor´s degree course or similar skills. In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.

6 Type of module examinations

The final examination consists of two parts: 120 min written examination about topics of the lectures and the practical/lab part (70 % of the total module mark), and an oral presentation (30 % of the total module mark)

Redoxbiochemistry (MN-BC-BSM-07) continued

7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula*** Subject module in the Master´s degree courses "Biological Sciences"
9	**Significance of the module mark for the overall grade** In the Master´s degree course "Biochemistry": 10 % of the overall grade (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Jan Riemer, phone 470-7306, e-mail: jan.riemer@uni-koeln.de
11	**Additional information** **Biochemical subject module** of the Master´s degree course "Biochemistry", **Literature:** • (i) Molecular Biology of the Cell, Alberts, B. et al., (ii) Biochemistry, Stryer, L., (iii) Additional subject-specific literature will be provided at the beginning of the module **Note:** The module contains hand-on laboratory work conducted by small groups of students and is taught in research laboratories. The module does not contain computer-based practicals/ research as a main component. **General time schedule:** Week 1: Lectures, Seminars, preparation for practical work, Week 2-5 (Mon.-Fri.): Lectures, practical/lab, Week 6 (Mon.-Fri.): Preparing poster and poster presentation; Week 7 (Mon.-Fri.): Preparation for the oral examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

* 6 students from the Master's degree course "Biochemistry", 4 students from the Master´s degree course "Biological Sciences"

Mitochondria and Neurodegeneration					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-BSM-08	360 h	12 CP	1st or 2nd term of studying	Summer term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	20 h	30 h	max. 12
	b) Practical/Lab	154 h	126 h	max. 2
	c) Seminar	6 h	24 h	max. 2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have gained in-depth knowledge in mitochondrial research and the role of mitochondrial dysfunction in neurodegeneration and aging.
- have acquired experimental skills in state-of-the art methods in cell biology and molecular biology (see contents of the module) and are able to independently design and perform small scientific projects related to topics of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Principles of mitochondrial biology including protein and membrane biogenesis, mitochondrial dynamics and inheritance, and mitochondrial genetics
- The role of mitochondrial dysfunction for aging and disease
- Mechanisms of mitochondrial quality control including autophagy and apoptosis
- The role of mitochondria for neuronal activities and survival
- Mitochondrial DNA mutations and human disease
- Mitochondria and neurodegenerative diseases including Parkinson disease, amyotrophic lateral sclerosis, hereditary spastic paraplegia, spinocerebellar ataxia, and peripheral neuropathies
- Analysis of subcellular localization of proteins using fluorescence microscopy and cellular fractionation
- Molecular cloning (cloning of PCR fragments into plasmids, transfections, etc.)
- Cell culture technology (working with human and murine cell lines)
- Immunohistochemistry
- Protein analysis and protein-interaction methods (Western blotting, co-immunoprecipitation of proteins, pull-down, etc.)
- Analysis of knock-out and transgenic mice

Explanatory note: The list above comprises techniques that are commonly used in the participating groups. Thus every student will be confronted with a large subset of it. The exact content, however, will depend on the tutor and the research project the student will work on.

* 2 students from the Master´s degree course “Biochemistry” and 10 students from the Master’s degree course “Biological Sciences”.

Mitochondria and Neurodegenration (MN-BC-BSM-08) continued

4	**Teaching/Learning methods** Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form
5	**Requirements for participation** Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the tutorials and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least “sufficient” (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master’s degree “Biological Sciences”
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master’s degree course “Biochemistry” (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Thomas Langer, phone 470-4876, e-mail: thomas.langer@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course “Biochemistry” **Literature:** • A list of literature that should be used for preparation to the module, can be obtained from http://www.genetik.uni-koeln.de/Teaching.html under "Advanced undergraduate courses". **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures, practical/lab and preparation for the seminar talk (topic and date will be arranged individually); Week 6 (Mon.-Fri.): Writing seminar paper; Week 7 (Mon.-Fri): Preparation for the written examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Peptide Biochemistry					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurence**	**Duration**
MN-BC-BSM-09	360 h	12 CP	1st or 2nd term of studying	Summer term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	25 h	50 h	max. 12
	b) Practical/Lab	154 h	103 h	max. 2
	c) Seminar	4 h	24 h	max. 4

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have a general understanding about the recent developments in the field of peptides including synthetic methodologies, biology of peptides and the application of peptides and peptide conjugates in medicinal or analytical context
- have acquired working skills to tackle the synthesis of peptides and peptide libraries, to apply deconvolution techniques, and to investigate peptide structure by biophysical methods.
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer the skills acquired in this module to other fields of biochemistry

3 Contents of the module

- Synthesis of peptides and proteins (i.e. solid phase peptide synthesis, native chemical ligation, Staudinger ligation, etc.)
- Peptide modifications (i.e. mimetics, labeling strategies, cyclic peptides)
- Peptide libraries, deconvolution
- Analytical methods (mass spectrometry, Edman degradation, fluorescence techniques, CD spectroscopy)
- Antimicrobial peptides, peptide hormones, cell-penetrating peptides, peptide targeting sequences
- Peptides in diagnostics and therapy

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form

* 4 students from the Master´s degree course “Biochemistry”, 4 students from the Master’s degree course “Biological Sciences” and 4 students from the Master´s degree course “Chemistry”.

Peptide Biochemistry (MN-BC-BSM-09) continued

5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry", in the Master's degree course "Biological Sciences" or in the Master´s degree course "Chemistry"
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master's degree course "Biological Sciences", combined advanced and experimental module in the Master's degree course "Chemistry"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Ines Neundorf, phone 470-8847, e-mail: ines.neundorf@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Sewald, N., Jakubke, H.-D. (2009) Peptides: Chemistry and Biology. 2nd edition, Wiley-VCH • Further original publications will be handed out at the introduction to the module **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures, practical/lab, preparation for the seminar talk (topic and date will be arranged individually); Week 6 (Mon.-Fri.): Writing seminar paper; Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted by small groups of students and individually and is taught in course rooms and research laboratories. The module does not contain computer-based practicals/ research as a main component. **Introduction to the module/examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html)

<table>
<tr><td colspan="6">Neurobiochemistry</td></tr>
<tr><td colspan="2">Identification number
MN-BC-BSM-10</td><td>Workload
360 h</td><td>Credit points
12 CP</td><td>Term of studying
1st or 2nd term of studying</td><td>Frequency of occurrence
Summer term, 2nd half</td><td>Duration
7 weeks</td></tr>
<tr><td>1</td><td colspan="2">Type of lessons
a) Lectures
b) Practical/Lab
c) Seminar</td><td>Contact times
25 h
154 h
4 h</td><td>Self-study times
50 h
103 h
24 h</td><td>Intended group size*
max. 8
max. 4
max. 4</td></tr>
<tr><td>2</td><td colspan="5">Aims of the module and acquired skills
Students who successfully completed this module …
• have acquired detailed knowledge about the structure-function relations of ligand-gated ion channels as well as synaptic proteins and their function within neuronal cells
• are able to isolate recombinantly expressed synaptic proteins from E. coli cultures
• can identify and characterize protein interactions between membrane receptors and synaptic proteins on a biochemical level using methods such as Isothermal Titration Calorimetry and Differential Scanning Calorimetry
• are able to apply the principle of immunodetection to microscopic samples as well as the immunoblot techniques
• have acquired sterile working practice by cultivating mammalian cell lines
• are able to express synaptic proteins in mammalian cell lines and analyze their interaction
• have prepared hippocampal neuron cultures and analyzed them at the confocal laser scanning microscope
• have the ability to process, quantify and evaluate their experimental results using different types of software
• have developed a structured and efficient way of working.
• have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
• are able to transfer skills acquired in this module to other fields of biochemistry.</td></tr>
<tr><td>3</td><td colspan="5">Contents of the module
• structure and function of neurons, voltage-gated and ligand-gated ion channels
• post-synaptic proteins and structures
• neuronal receptors in health and disease
• methods to visualize cellular structures and protein interactions (in vitro and in vivo)
• transfection of neuronal cells and HEK/COS7 cells
• preparation of cultures of hippocampal neurons from mouse brain
• immuno-staining of neuroreceptors and synaptic proteins
• confocal laser scanning microscopy
• model organisms: vertebrates – Mus musculus, prokaryotes – Escherichia coli</td></tr>
</table>

* 4 students from the Master´s degree course “Biochemistry” and 4 students from the Master’s degree course “Biological Sciences”.

Neurobiochemistry (MN-BC-BSM-10) continued

4	**Teaching/Learning methods** Lectures; Practical/Lab (Project work); Seminar; Computer exercises Guidance to independent research; Training on presentation techniques in oral and written form
5	**Requirements for participation** Enrollment in the Master´s degree course “Biochemistry”, in the Master’s degree course “Biological Sciences” or in the Master’s degree course “Chemistry”
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least “sufficient” (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master’s degree course “Biological Sciences”; combined advanced and experimental module in the Master’s degree course “Chemistry”
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master’s degree course “Biochemistry” (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Günter Schwarz, phone 470-6440, e-mail: gschwarz@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course “Biochemistry” **Literature:** • Kandel, E.R., Schwartz, J.H., Jessell, T. (2014) Principles of Neural Science. 5th edition, McGraw-Hill. Chapters 21, 22, 32. • Further original publications will be handed out at the introduction to the module **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures, practical/lab, preparation for the seminar talk (topic and date will be arranged individually); Week 6 (Mon.-Fri.): Writing seminar paper; Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted by small groups of students and individually and is taught in course rooms and research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Molecular Medicine – Molecular and Cellular Mechanisms in the Pathogenesis of Human Diseases					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-BSM-11	360 h	12 CP	1st or 2nd term of studying	Winter term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	8 h	40 h	max. 10
	b) Practical/Lab	140 h	120 h	max. 2
	c) Seminar	8 h	44 h	max. 10

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge on the molecular concepts of diseases related to mutated proteins in e.g. intracellular organelles, immune system, mitochondria or extracellular matrix.
- have learned how to use experimental model systems to analyze molecular disease mechanism.
- can apply flow cytometry to quantify protein levels on the cell surface and phenotype immune cell populations.
- are able to use label-free surface plasmon resonance (SPR) based technology for studying dysfunctional biomolecular interactions in real time.
- can analyze altered gene expression profiles by quantitative PCR approaches.
- can define mitochondrial dysfunction using bioenergetic measurements
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Molecular cloning, recombinant protein expression protein purification
- Flow cytometry
- Analysis of protein-protein interactions
- Gene expression analysis (array, quantitative PCR)
- Oxygen consumption measurements, mutation and copy number analysis of mtDNA (long-range and qPCR)
- Fluorescent tagged protein expression and imaging (GFP, HIS)
- Experimental gene regulation (siRNA, miRNA)
- Bioinformatics analysis of gene interaction networks
- Immunofluorescence, laser confocal scanning microscopy

Explanatory note: The exact content for each student will depend on the individual research project.

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

* 8 students from the Master´s degree course “Biochemistry” and 2 students from the Master’s degree course “Biological Sciences”.

Molecular Medicine – Molecular and Cellular Mechanisms in the Pathogenesis of Human Diseases (MN-BC-BSM-11) continued

5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry" or in the Master's degree course "Biological Sciences"
6	**Type of module examinations** The final examination consists of three parts: 30 min oral examination about the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master's degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Bent Brachvogel, phone 478-6996, e-mail: bent.brachvogel@uni-koeln.de
11	**Additional information** **Biochemical Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Flow cytometry: principles and clinical applications in hematology. Brown M1, Wittwer C. Clin Chem. 2000 Aug;46(8 Pt 2):1221-9. • Surface plasmon resonance as a high throughput method to evaluate specific and non-specific binding of nanotherapeutics. Schneider CS, Bhargav AG, Perez JG, Wadajkar AS, Winkles JA, Woodworth GF, Kim AJ. J Control Release. 2015 Dec 10;219:331-44. doi: 10.1016/j.jconrel.2015.09.048. Epub 2015 Sep 28 • The real-time polymerase chain reaction. Kubista M1, Andrade JM, Bengtsson M, Forootan A, Jonák J, Lind K, Sindelka R, Sjöback R, Sjögreen B, Strömbom L, Ståhlberg A, Zoric N .Mol Aspects Med. 2006 Apr-Jun;27(2-3):95-125. Epub 2006 Feb 3. • Mitochondrial DNA maintenance: an appraisal. Akhmedov AT, Marín-García J. Mol Cell Biochem. 2015 Nov;409(1-2):283-305. doi: 10.1007/s11010-015-2532-x. Epub 2015 Aug 19. **General time schedule:** Week 1-4 (Mon.-Fri.): Lectures, practical/lab; Week 5-6 (Mon.-Fri.): Preparation and oral presentation of an original research article, writing seminar paper; Week 7 (Mon.-Fri.): Preparation for the oral examination **Note:** The module contains hand-on laboratory work conducted by small groups of students and individually and is taught in course rooms and research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

2.2 Advanced Modules: General Subject Modules

<table>
<tr><td colspan="6">Model Systems of Aging and Age-related Diseases</td></tr>
<tr><td colspan="2">Identification number
MN-BC-GSM-01</td><td>Workload
360 h</td><td>Credit points
12 CP</td><td>Term of studying
1st or 2nd term of studying</td><td>Frequency of occurrence
Winter term, 1st half</td><td>Duration
7 weeks</td></tr>
<tr><td>1</td><td colspan="2">Type of lessons
a) Lectures
b) Practical/Lab
c) Seminar</td><td>Contact times
28 h
145 h
9 h</td><td>Self-study times
42 h
112 h
24 h</td><td>Intended group size*
max. 20
max. 3
max. 2</td></tr>
<tr><td>2</td><td colspan="5">Aims of the module and acquired skills
Students who successfully completed this module …
• have acquired detailed knowledge on important genetic concepts in modern aging research including key genetic model systems such as C. elegans, Drosophila, and mice.
• have acquired experimental skills in state-of-the art methodologies in cell biology and molecular biology and can independently carry out small scientific projects related to the topic of the module.
• have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
• are able to transfer skills acquired in this module to other fields of biochemistry.</td></tr>
<tr><td>3</td><td colspan="5">Contents of the module
• Genetic programs/mechanisms of aging
• Interplay between proteostasis, mitochondria, inflammation and aging
• Genetic control of tissue regeneration and tumor growth
• Basic cell biology mechanisms of cancer as an aging associated disease
• State of the art C. elegans and Drosophila techniques
• Eukaryotic cell culture
• DNA analysis by polymerase chain reaction (PCR), quantification of gene expression
• Gel electrophoresis (agarose and PAGE) and western blot
• Staining methods, immunohistochemistry, microscopy</td></tr>
<tr><td>4</td><td colspan="5">Teaching/Learning methods
Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form</td></tr>
<tr><td>5</td><td colspan="5">Requirements for participation
Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”</td></tr>
</table>

* 2 students from the Master´s degree course “Biochemistry” and 18 students from the Master’s degree course “Biological Sciences”.

Model Systems of Aging and Age-related Diseases (MN-BC-GSM-01) continued

6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Mirka Uhlirova, phone 478-84334, e-mail: mirka.uhlirova@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • A list of literature that should be used for preparation to the module, can be obtained from http://www.genetik.uni-koeln.de/Teaching.html under "Advanced undergraduate courses". **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures, practical/lab, writing seminar paper and preparation for the oral presentation (held at the end of week 6); Week 7 (Mon.-Fri): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted individually and is taught in research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Plant Genetics					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-02	360 h	12 CP	1st or 2nd term of studying	each term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	20 h	30 h	max. 16
	b) Tutorials	14 h	14 h	max. 16
	c) Practical/Lab	144 h	109 h	max. 6
	d) Seminar	5 h	24 h	max. 4

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have gained in-depth knowledge in up-to-date plant research topics. As this module also includes a section on molecular plant breeding which is co-taught by a plant breeder from a commercial breeding company, students will also gain transferable knowledge.
- are trained in modern techniques in advanced molecular biology, biochemistry and cell biology (see contents of the module).
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Theory of modern methods in molecular plant sciences (also used in other sciences)
- Molecular breeding of crop plants in Germany
- Plant developmental biology
- Molecular biology of plant-environment interactions (e.g. flowering time regulation by day length and temperature)
- Biotic interactions (e.g. symbiosis with mycorrhizal fungi)
- Protein-protein interactions (e.g. co-immunoprecipitations, FRET, co-localization)
- Genetic and molecular analysis of cell-cell communication (mutant analysis, plant transformation)
- Cell imaging using fluorescent and confocal microscopy
- Analysis of reporter gene activities, particle bombardment
- Real-time RT-PCR to analyze gene expression
- Computational analysis of next generation sequencing data (e.g. RNAseq)
- Other methods in modern molecular biology, biochemistry and cell biology

4 Teaching/Learning methods

Lectures; Interactive tutorials; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

* 1 student from the Master´s degree course “Biochemistry” and 15 students from the Master’s degree course “Biological Sciences”.

Plant Genetics (MN-BC-GSM-02) continued

5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry" or in the Master's degree course "Biological Sciences" **Additionally recommended:** Previous participation in a basic-level Bachelor course on plant science (normally taught during the first two years of Bachelor studies). You should know basic plant anatomy, plant hormones such as auxin and Mendelian genetics. Students with a more specialized BSc degree in Biotechnology sometimes lack this knowledge. In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper in form of a grant proposal (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Ute Höcker, phone 470-6897, e-mail: hoeckeru@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Smith, A., Coupland, G., Dolan, L., *et al.* (2009) Plant Biology. Garland Science • Buchanan, B., Gruissem, W., Russell, J. (2002) Biochemistry and Molecular Biology of Plants. Wiley-Blackwell • Taitz, L., Zeiger, E. (2006) Plant Physiology. 4th edition, Sinauer Associates • Lecture slides and a script containing all protocols used in the experimental part will be provided. **General time schedule:** Week 1-5 (Mon.- Fri.): Lectures, tutorials, practical/lab and writing seminar paper in form of a grant proposal; Week 6 (Mon.-Fri): Preparation for the seminar talk (held at the end of week 6); Week 7 (Mon.-Fri): Preparation for the written examination **Note:** The module contains hands-on laboratory work conducted in groups of max. two people and is taught in a course room fully equipped with up to date research technoilogy. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Analysis of High Dimensional (-omics) Data					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurence**	**Duration**
MN-BC-GSM-03	360 h	12 CP	1st or 2nd term of studying	Winter term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	36 h	72 h	max. 12
	b) Practical/Lab	84 h	140 h	max. 12
	c) Seminar	12 h	24 h	max. 4

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge about current methods for generating and analyzing genomics, proteomics and metabolomics data and are able to access these data from databases, and to process the various types of data with state of the art bioinformatics tools.
- are aware of the specific problems and pitfalls that arise in conjunction with the interpretation of high dimensional data and can introduce the basic techniques to cope with these problems, such as experimental design, normalization, dimension reduction, multiple testing correction, clustering and regression.
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Introduction to techniques for generating -omics data (deep sequencing, microarrays, mass spectrometry)
- Querying public repositories for -omics data
- Basic data structures and programming in R/Bioconductor, software for the processing of –omics data
- Visualization of high dimensional data
- Testing, classification, and regression
- Protein-protein and gene interaction screens, reconstruction of interaction networks
- Gene ontology analysis

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form

* 2 students from the Master´s degree course “Biochemistry” and 10 students from the Master’s degree course “Biological Sciences”.

Analysis of High Dimensional (-omics) Data (MN-BC-GSM-03) continued

5	**Requirements for participation** Enrollment in the Master´s degree course "Biochemistry" or in the Master's degree course "Biological Sciences" **Additionally recommended:** Basic knowledge of the statistical programming language R is indispensable to participate in this module. In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.
6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (weekly, aggregate to 25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Achim Tresch, phone 506-2161, e-mail: tresch@mpipz.mpg.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Reviews and original papers will be handed out during the module **General time schedule:** Weeks 1-6: Lectures (Mon., Wed., Fri. 2 h each), practical/lab (Mon. 2 h, Tue. 4 h, Wed. 2 h, Thu. 4 h, Fri. 2 h), seminars (Thu. 2 h), writing seminar paper and preparation for the seminar talk (topic and date will be arranged individually); Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module does not contain hand-on laboratory work. The module contains computer-based practicals/research as a main component and is taught in course rooms. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Modern Techniques of Developmental Biology					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-04	360 h	12 CP	1st or 2nd term of studying	each term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	12 h	24 h	max. 13
	b) Practical/Lab	162 h	129 h	max. 3
	c) Seminar	9 h	24 h	max. 6

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired theoretical and experimental skills concerning important techniques in developmental biology (see contents of the module).
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Genetic analysis of developmental processes
- Clonal analysis
- Advanced techniques of fluorescence microscopy
- Cell transplantations
- Cell ablations
- Transgenic techniques
- RNAi and morpholino knock-down of developmental genes
- Life-imaging of morphogenetic processes
- Cell migration and intracellular transport of mRNAs and proteins
- Basic techniques of molecular cloning (DNA preparation, transformation, ligation, RNA synthesis)
- Basic protein techniques (PAGE, Western blotting)

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

* 1 student from the Master´s degree course “Biochemistry” and 12 students from the Master’s degree course “Biological Sciences”.

Modern Techniques of Developmental Biology (MN-BC-GSM-04) continued

6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Siegfried Roth, phone 470-2491, e-mail: siegfried.roth@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Gilbert, S.F. (2006) Developmental Biology. 8th edition, Sinauer Associates • Wolpert, L., Jessel, T., Lawrence, P. *et al.* (2006) Principles of Development. 3rd edition, Oxford University Press • Review articles on particular topics will be provided during the course. **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures and practical/lab and preparation for the seminar talk (held in the weeks 4-6); Week 6 (Mon.-Fri): Writing seminar paper; Week 7 (Mon.-Fri): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted individually and is taught in research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Molecular Genetics					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-05	360 h	12 CP	1st or 2nd term of studying	Winter term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	20 h	40 h	max. 20
	b) Tutorial	120 h	148 h	max. 5
	c) Seminar	8 h	24 h	max. 4

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge of molecular genetics and the cellular repertoire to respond to stress and environmental signals operating at different levels in the cell from gene expression to protein function and signaling.
- are able to independently address and solve biological problems, including choice of accurate methods, appropriate data analysis and processing of data for publication.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Genetic screens, mutant selection and gene targeting in model organisms
- Spatial control of protein localization
- Cellular stress responses such as responses to starvation, temperature, and damaging agents
- Transcriptional and post-transcriptional regulation, as well as of post-translational regulation by protein modification
- Selective ubiquitin-mediated protein degradation and degradation of abnormal proteins in yeast and mammals
- Interactions between the virus and the host cell
- Addressing and solving scientific problems

4 Teaching/Learning methods

Lectures; Interactive tutorials; Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

6 Type of module examinations

The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (70 % of the total module mark) and oral presentation (30 % of the total module mark)

* 2 students from the Master´s degree course “Biochemistry” and 18 students from the Master’s degree course “Biological Sciences”.

Molecular Genetics (MN-BC-GSM-05) continued

7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** PD Dr. Niels Gehring, phone 470-3873, e-mail: ngehring@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Alberts, B., Bray, D., Lewis, J. (2008) Molecular Biology of the Cell. 5th edition, Taylor & Francis. Chapters 1 (pp 29-44), 6 (pp 355-365), 7, 8, 15 and 17 (pp 983-1010) • Lodish, H., Berk, A., Kaiser, C.A. *et al.* (2007) Molecular Cell Biology. 6th edition, Palgrave Macmillan. Chapters 3, 8, 13 and 14 • Watson, J.D., Baker, T.A., Bell, S.P. *et al.* (2008) Molecular Biology of the Gene. 6th edition, Benjamin Cummings. Chapters 12 and 16-18 • Current Protocols in Molecular Biology, Wiley Online Library http://onlinelibrary.wiley.com/book/10.1002/0471142727/toc • Current Protocols in Protein Science, Wiley Online Library http://onlinelibrary.wiley.com/book/10.1002/0471140864 **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures and tutorials (daily from approximately 9 a.m. to 3 p.m. including lunch break, times may vary depending on the topic of the tutorial), writing reports about the project studies and preparation for the seminar talk (held at the end of week 6); Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module does not contain hand-on laboratory work and is taught in course rooms. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Advanced Light Microscopy					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-06	360 h	12 CP	1st or 2nd term of studying	Summer term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	12 h	24 h	max. 6
	b) Practical/Lab	165 h	132 h	max. 2
	c) Seminar	3 h	24 h	max. 2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired theoretical and experimental skills in state-of-the art microscopy methodologies.
- are able to plan, carry out and evaluate a project using advanced microscopy and quantitative image analysis independently, as they will carry out individual research projects (4 weeks).
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biology.

3 Contents of the module

- Optical principles of light microscopy
- Design, build, and characterize a light microscope
- Quantitative image analysis
- Advanced fluorescence techniques (including FRAP, FRET, TIRF, Multi Photon, FLIM)
- Single cell and single molecule techniques
- Laser tweezers
- Superresolution microscopy
- Microfluidics
- Imaging of organisms (light sheet microscopy)

Explanatory note: To gain insight into state-of-the art methodologies the course will start with a combination of a lecture series and hands-on experience introducing different techniques (two weeks). The hands-on workshop will be jointly organized by the CECAD imaging facility and the experimental biophysics group. Four weeks of the course will be dedicated to designing and carrying out individual projects making use of advanced microscopy and image analysis in groups of two.

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

* 1 student from the Master´s degree course “Biochemistry” and 5 students from the Master’s degree course “Biological Sciences”.

Advanced Light Microscopy (MN-BC-GSM-06) continued

6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Berenike Maier, phone 470-8046, e-mail: berenike.maier@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Reviews and original papers will be handed out during the module **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures and practical/lab, writing seminar paper and preparation for the seminar talk (topic and date will be arranged individually); Week 7 (Mon.-Fri): Preparation for the written examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Population Genetics and Molecular Evolution					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-07	360 h	12 CP	1st or 2nd term of studying	Summer term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	37 h	74 h	max. 12
	b) Practical/Lab	48 h	171 h	max. 4
	c) Seminar	6 h	24 h	max. 12

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge on fundamental concepts and theoretical models in population genetics and molecular evolution.
- are able to measure, statistically evaluate and interpret genetic and gene expression data and put these in the context of molecular evolution.
- are skilled in the experimental generation and analysis of polymorphism data from natural populations and can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Principles of population genetics, population genomics and molecular evolution
- Molecular forensics
- Statistical tests of genetic data
- Mathematical modeling
- Intra- and interspecific comparative analyses of genome sequences
- Analysis of gene expression data
- Experimental extraction of polymorphism data involving DNA amplification, sequencing and genotyping

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Computer exercises; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

Additionally recommended: Good knowledge of quantitative methods is indispensable to participate in this module. Good mathematical skills are mandatory.

* 1 student from the Master´s degree course “Biochemistry” and 11 students from the Master’s degree course “Biological Sciences”.

Population Genetics and Molecular Evolution (MN-BC-GSM-07) continued

6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures (50 % of the total module mark), oral presentation (25 % of the total module mark) and seminar paper (weekly, aggregate to 25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula*** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Thomas Wiehe, phone 470-1588, e-mail: twiehe@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Nei, M. (2013) Mutation Driven Evolution. Wiley • Haubold, B., Wiehe, T. (2006) Introduction to Computational Biology. Birkhäuser • Further original papers will be handed out during the module **General time schedule:** Weeks 1-6: Lectures (Mon., Wed., Fri. 2 h each), practical/lab (Mon.-Thu. 2 h each), writing seminar paper and preparation for the seminar talk (held in week 4-6); Week 7 (Mon.-Fri.): Preparation for the written examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Advanced Bioinformatics

Identification number	Workload	Credit points	Term of studying	Frequency of occurrence	Duration
MN-BC-GSM-08	360 h	12 CP	1st or 2nd term of studying	Summer term, 2nd half	7 weeks

1	Type of lessons	Contact times	Self-study times	Intended group size*
	a) Lectures	18 h	36 h	max. 8
	b) Practical/Lab	99 h	159 h	max. 8
	c) Seminar	12 h	36 h	max. 8

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge about the experimental background of advanced methods in Bioinformatics and Computational Biology.
- have gained insight into contemporary topics of bioinformatic and biostatistical research and application to high-throughput data analysis.
- are able to use the above mentioned systems to analyze genome-scale data, conduct downstream analyses, and to interpret and document their research.
- can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Modern bioinformatic methods for genome, transcriptome and proteome data analysis
- Multi-variate and high-dimensional data analysis
- Advanced regression methods, such as generalized linear models
- Application of these methods to molecular biology and for understanding disease mechanisms
- Handling of Unix based computer systems
- Scientific programming

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

Additionally recommended: Successful completion of the module “Introduction to Bioinformatics (MN-BC-BSM-02)” or “Analysis of High Dimensional (-omics) Data (MN-BC-GSM-03)” or documented comparable skills. In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.

* 1 student from the Master´s degree course “Biochemistry” and 7 students from the Master’s degree course “Biological Sciences”.

Advanced Bioinformatics (MN-BC-GSM-08) continued

6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures and the practical/lab part (50 % of the total module mark), oral presentation (25 % of the total module mark) and written seminar paper (25 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Andreas Beyer, phone 478-84429, e-mail: andreas.beyer@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Lynch, M. (2007) The Origins of Genome Architecture. Palgrave Macmillan • Davidson, E.H. (2006) The Regulatory Genome. Academic Press • Hastie, T., Tibshirani, R., Friedman, J. (2009) The Elements of Statistical Learning. 2nd edition, Springer • Additional reviews and original papers will be handed out during the module **General time schedule:** Week 1-5 (Mon.-Fri.): Lectures, practical/lab, preparation for the seminar talk (topic and date will be arranged individually); Week 6 (Mon.-Fri.): Writing seminar paper; Week 7 (Mon.-Fri.): Preparation for the written examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Mouse Genetics, Cell Death and Inflammation					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-09	360 h	12 CP	1st or 2nd term of studying	Summer term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size**
	a) Lectures	26 h	39 h	max. 12
	b) Practical/Lab	145 h	120 h	max. 4
	c) Seminar	6 h	24 h	max. 2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge on important concepts in modern mouse genetics.
- have acquired experimental skills in the use of several important molecular biological methods (see contents of the module) and are able to independently design and perform small scientific projects related to topics of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biology.

3 Contents of the module

- Cre recombinase
- CRISPR/Cas9
- DNA and protein purification
- Quantifying DNA and proteins
- Gel electrophoresis (agarose and PAGE)
- Eukaryotic cell culture
- Transfection of fibroblasts
- Staining methods, immunohistochemistry, confocal and fluorescent microscopy
- DNA analysis by polymerase chain reaction (PCR)
- EMSA
- Western blot
- FACS
- Cell death assay

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

* 1 student from the Master´s degree course “Biochemistry” and 11 students from the Master’s degree course “Biological Sciences”.

Mouse Genetics, Cell Death and Inflammation (MN-BC-GSM-09) continued

5	**Requirements for participation** Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”
6	**Type of module examinations** The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (70 % of the total module mark) and oral presentation (30 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least “sufficient” (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course “Biological Sciences”
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master’s degree course “Biochemistry” (see also appendix of the examination regulations)
10	**Module coordinator** Dr. Teresa Corona, phone 81-84362, e-mail: tcorona@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course “Biochemistry” **Literature:** • A list of literature that should be used for preparation for the module will be available athttp://www.genetik.uni-koeln.de/groups/Pasparakis/PasparakisNews.html **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures, practical/lab, writing seminar paper and preparation for the seminar talk (topic and date will be arranged individually); Week 7 (Mon.-Fri): Preparation for the written examination **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

<table>
<tr><td colspan="7">Advanced Chemistry</td></tr>
<tr><td colspan="2">Identification number
MN-BC-GSM-10</td><td>Workload
360 h</td><td>Credit points
12</td><td colspan="2">Term of studying
1st or 2nd term of studying</td><td>Frequency of occurence
Each term

Duration
whole term</td></tr>
<tr><td>1</td><td colspan="2">Type of lessons
a) Lectures
b) Seminar</td><td>Contact times
60 h
30 h</td><td>Self-study times
180 h
90 h</td><td colspan="2">Intended group size
a) 20-30 students
b) 20-30 students</td></tr>
<tr><td>2</td><td colspan="6">Aims of the module and acquired skills
After completion of this module students...
• are familiar with current aspects of advanced inorganic, organic or physical chemistry and know the most important research fields of the mentioned subject areas
• are able to understand sophisticated and advanced topics in inorganic, organic or physical chemistry and to critically discuss scientific publications
• have learned to present research results in oral form and to critically discuss scientific publications related to the topic of the module on a professional level
• are able to transfer skills acquired in this module to other fields of biochemistry.</td></tr>
<tr><td>3</td><td colspan="6">Contents of the module
Two lectures of two out of the following three chemical subjects are chosen, the seminar is chosen out the two lecture topics:
<u>Inorganic Chemistry</u>:
• Molecular chemistry of main group elements; Modern bonding theories
• Coordination chemistry
• Preparative solid-state chemistry, Fundamental organometallic reactions and transformation
• Chemical reactions in the gas phase; chemical transport (CV/CVT); Physical and chemical vapor phase synthesis (PVD/CVD/ALD)
<u>Organic Chemistry</u>
• Pericyclic reactions
• Radical reactions
• Polar reactions
• Organometallic chemistry
• Heterocycle synthesis
• Biological Organic Chemistry
• Physical Organic Chemistry
• Natural product chemistry
<u>Physical Chemistry</u>
• spectroscopy (rotational and vibrational transitions, electronic transitions, lasers, magnetic resonance)
• statistical thermodynamics (basic concepts and applications)</td></tr>
</table>

Advanced Chemistry (MN-BC-GSM-10) continued

	• electric and magnetic properties of molecules • applied electrochemistry • macromolecules • surfaces and interfaces, colloid-disperse systems *Explanatory note:* The detailed contents of these chemical subjects are described as "A-modules" in the module compendium of the Master's degree course "Chemistry" (http://www.chemie.uni-koeln.de/docs.html). Two out of three chemical subjects (corresponding to "A-modules" in the Master's degree course "Chemistry") in the areas of inorganic, organic and/or physical chemistry have to be chosen. The student attends the lectures of the two chosen chemical subjects and participates in one of the corresponding seminars.
4	**Teaching/Learning methods** Lectures; Seminar; Training on presentation techniques in oral form
5	**Requirements for participation** Enrollment in the Master's degree course "Biochemistry" or in the Master's degree course "Chemistry"
6	**Type of module examinations** The final examination consists of two parts: one written examination about topics of the lectures in chemical subject 1 (50 % of the total module mark), one written examination about topics of the lectures in chemical subject 2 (50 % of the total module mark).
7	**Requisites for the allocation of credits** Regular and active participation; passed oral presentation in the chosen seminar series. Total module mark at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** None
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Inorganic Chemistry: Prof. Dr. S. Mathur, phone 470-4107, e-mail: sanjay.mathur@uni-koeln.de Organic Chemistry: Prof. Dr. A. Berkessel, phone 470-3283, e-mail: berkessel@uni-koeln.de Physical Chemistry: Prof. Dr. A. Schmidt, phone 470-5410, e-mail: annette.schmidt@uni-koeln.de
11	**Additional information** **General Subject Module** in the Master's degree course "Biochemistry" **Literature:** see module description: http://www.chemie.uni-koeln.de/docs.html Information about literature will be provided via ILIAS. **General time schedule:** see KLIPS 2.0. **Introduction to the module/Examination dates:** see KLIPS 2.0, Information about seminar subjects will be provided via ILIAS. The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Functional Genomics					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-11	360 h	12 CP	1st or 2nd term of studying	Winter term, 2nd half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	22 h	50 h	max. 16
	b) Practical/Lab	150 h	100 h	max. 2
	c) Seminar	8 h	30 h	max. 2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge in the concepts of functional genomics and the role of genome regulation in physiology and disease.
- have acquired experimental skills in state-of-the art methods in genomics, cell biology and molecular biology and can independently carry out small scientific projects related to the topic of the module.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Evolution of genomes and traits
- Regulation of nuclear and chromatin architecture
- Epigenetic regulation of gene expression
- Principles of transcriptional regulation
- Identification of longevity genes
- Model organisms for functional genomics and ageing research
- Next generation sequencing methods for genomic analyses
- Genetic screening
- Genetic reprogramming
- Chromatin immunoprecipitation
- Cloning methods
- Cell biology, immunological staining methods, microscopy

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

* 2 students from the Master´s degree course “Biochemistry” and 14 students from the Master’s degree course “Biological Sciences”.

Functional Genomics (MN-BC-GSM-11) continued

6	**Type of module examinations** The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (70 % of the total module mark) and oral presentation (30 % of the total module mark)
7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Dr. Sara Wickström, phone 379 70 770, e-mail: wickstroem@age.mpg.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • A list of literature that should be used for preparation to the module can be obtained from http://www.genetik.uni-koeln.de/Teaching.html under "Advanced undergraduate courses" **General time schedule:** Week 1 (Mon.-Fri.): Introduction to Functional Genomics (lectures), safety lecture and lab projects; Week 2-6 (Mon.-Fri.): Lectures, seminars and; Week 7 (Mon.-Fri): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted individually and is taught in research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Microbial Genetics					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-12	360 h	12 CP	1st or 2nd term of studying	Winter term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	10 h	50 h	max. 12
	b) Practical/Lab	180 h	80 h	max. 2-3
	c) Seminar	10 h	30 h	max. 1-2

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge of microbial genetics and the cellular repertoire of Yeast (*Saccharomyces cerevisiae*) and *Escherichia coli* to regulate gene and protein function as well as to respond to stress and environmental signals operating at different levels in the cell from gene expression to protein function and signaling.
- are able to address a scientific question related to the topic of the module by independently planning and conducting an experimental project, including choice of accurate methods, appropriate data compilation, accurate documentation of experiments as well as analysis and interpretation.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.
- are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Planning and conduction of an individual project (in teams of 2 to 3 students)
- Methods of gene targeting and site-directed mutagenesis
- Analysis of transcriptional and post-transcriptional regulation
- Analysis of protein-protein interaction and protein photo-crosslinking
- Characterization of post-translational regulation of protein function and selective protein degradation
- Standard molecular genetic techniques (cloning, protein expression, sequencing, etc.)
- Selection and characterization of mutants

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

* 1 student from the Master´s degree course “Biochemistry” and 11 students from the Master’s degree course “Biological Sciences”.

Microbial Genetics (MN-BC-GSM-12) continued

6	**Type of module examinations** The final examination consists of three parts: Two hours written examination about topics of the lectures/tutorials (50 % of the total module mark), oral presentation (25 % of the total module mark), and seminar paper (25 % of the total module mark).
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least “sufficient” (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course “Biological Sciences”
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master’s degree course “Biochemistry” (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Karin Schnetz, phone 470-3815, e-mail: schnetz@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course “Biochemistry” **Literature:** A list of literature that should be used for preparation to the module can be obtained from http://www.genetik.uni-koeln.de/Teaching.html under "Advanced undergraduate courses". **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures/tutorials and practical/lab (daily from approximately 9 a.m. to 5 p.m. including lunch break, times may vary depending on practical/lab work), writing reports about the project studies and preparation for the seminar talk (held at the end of week 6); Week 7 (Mon.-Fri.): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted by small groups of students and is taught in course rooms. The module does not contain computer-based practical/ research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

Methods and Techniques in Chemical Ecology					
Identification number	**Workload**	**Credit points**	**Term of studying**	**Frequency of occurrence**	**Duration**
MN-BC-GSM-13	360 h	12 CP	1st or 2nd term of studying	Summer term, 1st half	7 weeks

1	**Type of lessons**	**Contact times**	**Self-study times**	**Intended group size***
	a) Lectures	23 h	46 h	max. 8
	b) Practical/Lab	152 h	111 h	max. 8
	c) Seminar	4 h	24 h	max. 8

2 Aims of the module and acquired skills

Students who successfully completed this module …

- have acquired detailed knowledge on chemical ecology in aquatic systems, especially on the role of infochemicals, toxins and essential nutrients.
- are able to extract and derivatize fatty acids and to perform quantitative analysis by GC-FID
- are familiar with quantification based on internal or external standards
- are able to enrich volatiles from water and headspace by static and dynamic techniques and to analyse them by GC-MS
- are familiar with high-resolution UPLC-MS
- can independently carry out small scientific projects related to the topic of the module.
- can design biotests to assess the biological activity of such substances and can use different techniques of isolating and quantifying them from biological organisms.
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level.are able to transfer skills acquired in this module to other fields of biochemistry.

3 Contents of the module

- Extraction of volatile and more polar compounds from water
- Chromatography (HPLC, UPLC, GC)
- Chromatography coupled to mass spectrometry (LC-MS, GC-MS)
- Accomplishment and analysis of bioassays
- Current topics in Aquatic Chemical Ecology, in particular chemical communication, toxins and essential nutrients

4 Teaching/Learning methods

Lectures; Practical/Lab (Project work); Seminars; Excursions; Guidance to independent research; Training on presentation techniques in oral and written form

5 Requirements for participation

Enrollment in the Master´s degree course “Biochemistry” or in the Master’s degree course “Biological Sciences”

Additionally recommended: Knowledge of fundamental ecological principles is indispensable to participate in this module. In cases of doubt, please contact the module coordinator (see 10) before choosing this subject module.

* 2 students from the Master´s degree course “Biochemistry” and 6 students from the Master’s degree course “Biological Sciences”.

Methods and Techniques in Chemical Ecology (MN-BC-GSM-13) continued

6	**Type of module examinations** The final examination consists of two parts: Two hours written examination about topics of the lectures and the practical/lab part (70 % of the total module mark) and oral presentation (30 % of the total module mark).
7	**Requisites for the allocation of credits** Regular and active participation; Passed seminar paper; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** Subject module in the Master´s degree course "Biological Sciences"
9	**Significance of the module mark for the overall grade** 10 % of the overall grade in the Master's degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Eric von Elert, phone 470-6084, e-mail: evelert@uni-koeln.de
11	**Additional information** **General Subject Module** of the Master´s degree course "Biochemistry" **Literature:** • Brönmark, C., Hansson, L.A. (2012) Chemical Ecology in Aquatic Systems. Oxford University Press • Additional reviews and original papers will be handed out during the module **General time schedule:** Week 1-6 (Mon.-Fri.): Lectures, practical/lab and preparation for the seminar talk (topic and date will be arranged individually) as well as writing seminar paper; Week 7 (Mon.-Fri): Preparation for the written examination **Note:** The module contains hand-on laboratory work conducted by small groups of students and is taught in research laboratories. The module does not contain computer-based practicals/research as a main component. **Introduction to the module:** The dates of the introduction to the module and of the examinations will be announced in regularly updated subject module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html).

2.3 Advanced Module: Scientific Writing

<table>
<tr><td colspan="7">Scientific Writing</td></tr>
<tr><td colspan="2">Identification number
MN-BC-SW</td><td>Workload
180 h</td><td>Credit points
6 CP</td><td colspan="2">Term of studying
1st term of studying</td><td>Frequency of occurrence
Winter term</td><td>Duration
4 weeks, 3-4 days mandatory attendance</td></tr>
<tr><td>1</td><td colspan="3">Type of lessons
Interactive Tutorials and Project work</td><td>Contact times
approx. 60 h</td><td>Self-study times
approx. 120 h</td><td colspan="2">Intended group size
max. 20</td></tr>
<tr><td>2</td><td colspan="7">Aims of the module and acquired skills
Students who successfully completed this module …
• are able to structure a scientific publication, such as research papers, master thesis, research proposals, scientific essays etc.
• are able to identify their target audience and address them adequately in the written or oral presentation
• have learned to write concise, clearly structured, consistently using scientific language
• have improved their own scientific writing style and enhanced their scientific vocabulary</td></tr>
<tr><td>3</td><td colspan="7">Contents of the module
• Structuring scientific publications and research proposals
• Writing with the reader in mind
• Characteristics of good scientific writing
• Main principles of scientific sentence structures and stress positions
• Special software for writing, illustrating and layout
• Editing skills
• Literature and patent research
• Referencing techniques
• Preparation of figures and legends</td></tr>
<tr><td>4</td><td colspan="7">Teaching/Learning methods
Interactive tutorials and project work. Guidance to independent writing and language skills; Training on writing techniques by means of project work.</td></tr>
<tr><td>5</td><td colspan="7">Requirements for participation
Enrollment in the Master´s degree course “Biochemistry”</td></tr>
<tr><td>6</td><td colspan="7">Type of module examinations
The final examination consists of a seminar paper.</td></tr>
<tr><td>7</td><td colspan="7">Requisites for the allocation of credits
Regular and active participation; Total module mark at least “sufficient” (see appendix of the examination regulations for details).</td></tr>
</table>

Scientific Writing (MN-BC-SW) continued

8	**Compatibility with other Curricula** None
9	**Significance of the module mark for the overall grade** 5 % of the overall grade (see also appendix of the examination regulations)
10	**Module coordinator** Prof. Dr. Günter Schwarz, phone 470-6440, e-mail: gschwarz@uni-koeln.de
11	**Additional information** **Compulsory Advanced Module** of the Master´s degree course "Biochemistry" **Note:** The module does not contain hand-on laboratory work and is taught in course rooms. The module contains computer-based research as a main component. **General time schedule:** Weeks 1-2: Tutorials and Project Work; Weeks 3- 4: Writing seminar paper **Introduction to the module:** The dates of the introduction will be announced in regularly updated module descriptions that will be posted in the internet in time before registration to the module (see http://www.bc.uni-koeln.de/13941.html)

2.4 Specialization Modules

Laboratory Module						
Identification number	**Workload**	**Credit points**	**Term of studying**		**Frequency of occurrence**	**Duration**
MN-BC-LM1/2	540 h	18 CP	2nd or 3rd term of studying		all year round	12 weeks
1	**Type of lessons** Interactive Tutorials, Project work and Seminar		**Contact times** approx. 360 h	**Self-study times** approx. 180 h	**Intended group size** max. 1	
2	**Aims of the module and acquired skills** Students who successfully completed this module … • have learned to do scientific work in a specific field of a given research group. • have understood how to plan and conduct a small scientific project. • have gained experience in following the presentation of scientific material by others in the frame of the seminar program of a research group. • have learned how to present research results in oral and written form and to critically discuss scientific publications.					
3	**Contents of the module** The detailed content of the Laboratory Module is proposed by the supervising tutor on an individual basis in agreement with the student. The content requires approval by the M.Sc. Biochemistry Degree Committee. A Laboratory Module may be supervised by any member of staff qualified under the University Regulation § 65 HG.					
4	**Teaching/Learning methods** Interactive tutorials; Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form					
5	**Requirements for participation** Enrollment in the Master´s degree course “Biochemistry”; Successful completion of at least one Biochemical Subject Module					
6	**Type of module examinations** The final examination consists of two parts: 20 min oral presentation followed by a 10-30 min discussion of the presented work and the scientific background (30 % of the total module mark) and seminar paper (70 % of total module mark).					
7	**Requisites for the allocation of credits** Regular and active participation; Each examination part at least “sufficient” (see appendix of the examination regulations for details)					

Laboratory Module (MN-BC-LM1/2) continued

8	**Compatibility with other Curricula** None
9	**Significance of the module mark for the overall grade** In the Master´s degree course "Biochemistry": 10 % of the overall grade (see also appendix of the examination regulations)
10	**Module coordinator** Head of the M.Sc. Biochemistry Degree Committee, at present: Prof. Dr. Ulrich Baumann, phone 470-3209, e-mail: ubaumann@uni-koeln.de
11	**Additional information** **Compulsory Specialization Module** of the Master's degree course "Biochemistry". **Note:** A student may not do both laboratory modules in one research group. **Literature:** • Will be handed out at the beginning and during the module **General time schedule:** Week 1-9 (Mon.-Fri.): Tutorials, practical/lab and seminars as well as preparation for the seminar talk (topic and date will be arranged individually); Week 10-12 (Mon.-Fri): Writing seminar paper and preparation of the oral presentation **Introduction to the module/Examination dates:** The dates of the introduction to the module and of the examinations will be arranged in agreement between the student and the supervising tutor. Forms for application and approval can be downloaded at : http://www.bc.uni-koeln.de/16219.html

<table>
<tr><td colspan="7">Project Proposal</td></tr>
<tr><td colspan="2">Identification number

MN-BC-PP</td><td>Workload

180 h</td><td>Credit points

6 CP</td><td colspan="2">Term of studying

3rd term of studying</td><td>Frequency of occurence

all year round</td><td>Duration

4 weeks</td></tr>
<tr><td>1</td><td colspan="3">Type of lessons
Interactive Tutorials, Project work</td><td>Contact times
approx. 30 h</td><td>Self-study times
approx. 150 h</td><td colspan="2">Intended group size
max. 1</td></tr>
<tr><td>2</td><td colspan="7">Aims of the module and acquired skills
Students who successfully completed this module …
• have learned to search the literature, to identify papers with important impact in the field and to extract relevant information in respect to their own research topic
• are able to develop a working hypothesis, theory or model that explains a biochemical mechanism and/or biochemical problem which has been studied in a research project
• are able to propose reasonable experiments and define expected positive and negative outcomes including control experiments
• are able to develop a work plan using different and complementary experimental approaches to prove or disprove their hypothesis
• have learned to describe and to critically discuss a state-of-the-art method</td></tr>
<tr><td>3</td><td colspan="7">Contents of the module
The Project Proposal Module may be supervised by any member of staff qualified under the University Regulation § 65 HG. The subject of the Project Proposal is developed with the supervising tutor on an individual basis in agreement with the student. It may cover the following areas:
• Review of the results of the passed laboratory module (MN-BC-LM1/2) and definition of the strength and weaknesses of the available results and data
• Description of the state-of -the-art research in a specific field by searching the literature and extracting the most important and influential work in the field (include citations)
• Definition of new research aims and hypothesis
• Identification of key methods and technologies that can be applied, including a critical discussion of 1-2 key methods with advantages and disadvantages in a separate essay
• Development of a work plan including in detail description and justification of experimental approaches
• Suggestion of alternative approaches, identification of pit falls and definition of crucial control experiments
• Timed work schedule</td></tr>
<tr><td>4</td><td colspan="7">Teaching/Learning methods
Interactive tutorials; Guidance to independent research project planning and proposal writing; Training on presentation techniques in written form; literature search; Essay writing</td></tr>
</table>

Project Proposal (MN-BC-PP) continued

5	**Requirements for participation** Enrollment in the Master´s degree course “Biochemistry”; Successful completion of four advanced modules and two specialization modules
6	**Type of module examinations** The final examination consists of a written seminar paper including a project proposal (Part A) and a method essay (Part B).
7	**Requisites for the allocation of credits** Regular and active participation; Total module mark at least “sufficient” (see appendix of the examination regulations for details).
8	**Compatibility with other Curricula** None
9	**Significance of the module mark for the overall grade** 5 % of the overall grade (see also appendix of the examination regulations)
10	**Module coordinator** Head of the M.Sc. Biochemistry Degree Committee, at present: Prof. Dr. Ulrich Baumann, phone 470-3209, e-mail: ubaumann@uni-koeln.de
11	**Additional information** **Compulsory Specialization Module** of the Master’s degree course “Biochemistry”. **Literature:** Will be handed out at the beginning and during the module **General time schedule**: Week 1-3 (Mon.-Fri.): Interactive tutorials, literature search, preparation of the seminar paper; Week 4 (Mon.-Fr.): writing seminar paper **Introduction to the module/Examination dates**: The dates of the introduction to the module and of the examinations will be arranged in agreement between the student and the supervising tutor.

<table>
<tr><td colspan="7">Master Thesis & Defense</td></tr>
<tr><td colspan="2">Identification number
MN-BC-MT</td><td>Workload
1080 h</td><td>Credit points
36 CP</td><td colspan="2">Term of studying
4th term of studying</td><td>Frequency of occurrence
all year round</td><td>Duration
7 month*</td></tr>
<tr><td>1</td><td colspan="2">Type of lessons
a) Master Thesis
b) Defense</td><td colspan="2">Contact times
According to the individual demand of the student</td><td>Self-study times
According to the individual need of the student</td><td colspan="2">Intended group size
max. 1</td></tr>
<tr><td>2</td><td colspan="7">Aims of the module and acquired skills
Students who successfully completed this module …
• have learned to perform scientific work independently and at a demanding level.
• have gained substantial further training in presenting their results to scientific audiences in written and oral form.
• are able to defend their scientific achievements and to develop their own ideas within their research fields.</td></tr>
<tr><td>3</td><td colspan="7">Contents of the module
• The detailed content of the Master Thesis (30 CP) is proposed by the supervising tutor on an individual basis in agreement with the student and has to be approved by the M.Sc. Biochemistry Degree Committee. The Master Thesis may be supervised by any member of staff qualified under the University Regulation § 65 HG.
• The Defense (6 CP) consists of a 20 min talk on the results of the thesis and is followed by a 25-40 min discussion on the thesis as well as its scientific background.</td></tr>
<tr><td>4</td><td colspan="7">Teaching/Learning methods
Practical/Lab (Project work); Seminar; Guidance to independent research; Training on presentation techniques in oral and written form</td></tr>
<tr><td>5</td><td colspan="7">Requirements for participation
Successful completion of all other modules of the Master´s degree course “Biochemistry”.
Thesis: Formal written permission by the M.Sc. Biochemistry Degree Committee before starting the module (application form can be obtained from http://www.bc.uni-koeln.de/16219.html).
Defense: Successful completion of the Master Thesis with a grade of at least “sufficient”.</td></tr>
<tr><td>6</td><td colspan="7">Type of module examinations
The final examination consists of two parts: Master Thesis (75 % of the total module mark), Defense of the Master Thesis (25 % of the total module mark).</td></tr>
<tr><td>7</td><td colspan="7">Requisites for the allocation of credits
Each examination part at least “sufficient” (see appendix of the examination regulations for details)</td></tr>
<tr><td>8</td><td colspan="7">Compatibility with other Curricula
None</td></tr>
</table>

Master Thesis (MN-BC-MT) continued

9	**Significance of the module mark for the overall grade** 40 % of the overall grade in the Master´s degree course "Biochemistry" (see also appendix of the examination regulations)
10	**Module coordinator** Head of the M.Sc. Biochemistry Degree Committee, at present: Prof. Dr. Ulrich Baumann, phone 470-3209, e-mail: ubaumann@uni-koeln.de
11	**Additional information** **Final Specialization Module** of the Master's degree course "Biochemistry". • In case a student cannot find a supervisor for this module, it is the responsibility of the M.Sc. Biochemistry Degree Committee to arrange for one. • The topic of a Master Thesis may be changed once and within the first four weeks. • In special circumstances the M.Sc. Biochemistry Degree Committee may prolong the duration of a Master Thesis by four weeks. • Forms for application and approval can be downloaded at : http://www.bc.uni-koeln.de/16219.html