UNIVERSITÄT OSNABRÜCK

FACHBEREICH PHYSIK UND FACHBEREICH BIOLOGIE/CHEMIE

MODULBESCHREIBUNGEN

FÜR DEN MASTERSTUDIENGANG

„NANOSCIENCES – MATERIALS, MOLECULES AND CELLS“

beschlossen in der
291. Sitzung des Fachbereichsrats Physik am 17.05.2017
und in der 123. Sitzung des Fachbereichsrats Biologie/Chemie am 05.07.2017
befürwortet in der 139. Sitzung der Ständigen zentralen Kommission für Studium und Lehre und Studienqualitätskommission (ZSK) am 25.10.2017
genehmigt in der 269. Sitzung des Präsidiums am 22.03.2018
AMBl. der Universität Osnabrück Nr. 03/2018 vom 24.05.2018, S. 292

Änderungen
beschlossen in der
301. Sitzung des Fachbereichsrats Physik am 08.05.2019
und in der 133. Sitzung des Fachbereichsrats Biologie/Chemie am 27.02.2019 sowie in der 137. Sitzung des Fachbereichsrats Biologie/Chemie am 09.09.2019
befürwortet in der 150. und 152. Sitzung der Ständigen zentralen Kommission für Studium und Lehre und Studienqualitätskommission (ZSK) am 29.05.2019 sowie am 16.10.2019
genehmigt in der 296. Sitzung des Präsidiums am 14.11.2019
AMBl. der Universität Osnabrück Nr. 01/2020 vom 10.03.2020, S. 41

Änderungen
beschlossen in der
316. Sitzung des Fachbereichsrats Physik am 20.04.2022 und per Beschluss des Dekanats des Fachbereichs Physik am 26.09.2022
und per Umlaufverfahren des Fachbereichsrats Biologie/Chemie am 09.05.2022 sowie am 24.10.2022
befürwortet in der 170. Sitzung der Ständigen zentralen Kommission für Studium und Lehre und Studienqualitätskommission (ZSK) am 26.10.2022
genehmigt in der 365. Sitzung des Präsidiums am 17.11.2022
AMBl. der Universität Osnabrück Nr. 09/2022 vom 20.12.2022, S. 1899

Biologie

Identifier	Module title	Courses language
BIO-NMM-BC1_v1	**Master Module Biochemistry: Structural and Pathobiochemistry** *German module title* *Mastermodul Biochemie: Strukturelle und Pathobiochemie*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Biochemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students will acquire advanced scientific competences. They acquire in-depth knowledge of selected structural biological, biochemical and cell biological processes (see "contents") and develop an understanding of the processes and interrelationships involved. They will be able to transfer this knowledge to new situations and derive conclusions. They apply more demanding laboratory biochemical, biophysical, molecular biological and cell biological methods. Data collected experimentally using these methods will be carefully analysed, evaluated using standard statistical procedures, presented graphically, and critically discussed. The students acquire technical and methodological content from English-language review and technical articles, research the literature important for the respective technical environment, prepare a presentation for this, and master the common rules of presenting scientific data. They reflect and discuss the technical and methodological aspects of the respective topic and assess the quality of their own presentation as well as that of their fellow students. In doing so, they apply the usual feedback rules.

Content

LECTURE: Structural and cell biological methodology and analytics, protein biogenesis, signal transduction, lysosomal signalling, autophagy, membrane contacts and lipid transport, lipid droplets, biosynthesis and biogenesis of cholesterol, phospholipids and sphingolipids, rare diseases….
SEMINAR: Presentation and discussion of cell biology-biochemistry publications, presentations and discussions in English.
EXERCISES: techniques of molecular cell biology, cell transformation, subcellular fractionation & biochemical characterizations, in vitro analysis of protein complexes, protein purification, protein and organelle dynamics, microscopic cell examination.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		basic knowledge in biochemistry and cell biology (Bachelor class level)	Written examination or MC exam on the contents of the module (usually 90 min.) or protocol or seminar presentation or oral examination as specified by the lecturer at the beginning of the course.

2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Specialized scientific competencies on the sub-aspects of biochemistry and molecular cell biology as described under "contents" are tested.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Basic module in Biochemistry or Cell Biology at the bachelor level.

Identifier	**Module title**	**Courses language**
BIO-NMM-BC2_v1	**Master Module Biochemistry: Molecular Cell Biochemistry: Intracellular Protein Sorting and Function** *German module title* *Mastermodul Biochemie: Molekulare Zellbiologie/Biochemie: intrazelluläre Proteinsortierung und -funktion*	English

Module SWS (contact hours per week during semester)	**Module duration**	**Authorized module representative**
8 SWS	1 semester	Lecturers in Biochemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students will acquire advanced scientific competences. They acquire in-depth knowledge of selected structural biological, biochemical and cell biological processes (see "contents") and develop an understanding of the processes and interrelationships involved. They will be able to transfer this knowledge to new situations and derive conclusions. They will apply more demanding laboratory biochemical, biophysical, molecular biological and cell biological methods. Data collected experimentally using these methods will be carefully analysed, evaluated using standard statistical procedures, presented graphically, and critically discussed. The students acquire technical and methodological content from English-language review and technical articles, research the literature

important for the respective technical environment, prepare a presentation for this, and master the common rules of presenting scientific data. They reflect and discuss the technical and methodological aspects of the respective topic and assess the quality of their own presentation as well as that of their fellow students. In doing so, they apply the usual feedback rules.

Content

LECTURE: Molecular and cell biological methodology and analytics, protein folding, protein sorting, exocytosis, endocytosis, vesicle traffic, protein complexes involved, cytoskeleton, signal transduction, cell-cell communication.

SEMINAR: Presentation and discussion of cell biology-biochemistry publications, presentations and discussions in English.

EXERCISES: Techniques of molecular cell biology, cell transformation, subcellular fractionation & biochemical characterizations, in vitro analysis of protein complexes, protein purification, protein and organelle dynamics, microscopic cell examination.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		Basic knowledge in biochemistry and cell biology (Bachelor class level)	Written examination or MC exam on the contents of the module (usually 90 min.) or protocol or seminar presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Specialized scientific competencies on the sub-aspects of biochemistry and molecular cell biology as described under “Contents” are tested.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Basic module in Biochemistry or Cell Biology at the bachelor level.

Identifier	Module title	Courses language
BIO-NMM-BO	**Master Module Botany: Molecular Plant Developmental Genetics** *German module title* *Mastermodul Botanik: Molekulare Entwicklungsgenetik der Pflanzen*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Botany: S. Zachgo
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	Fachbereichsrat Biologie/Chemie

Learning objectives

Plant embryo development and organogenesis is initiated from totipotent stem cells, which are maintained by plants throughout their life cycle, representing a unique and advantageous feature of plants. Starting from stem cells, tissue differentiation and organogenesis enable, in the context of variable ecosystems, adaptations to changing environments. Students learn about key regulators and cellular as well as molecular signalling mechanisms leading to the formation of vegetative organs, and differently from animals, induction of the sexual reproduction after embryogenesis.
Methodologically, a comprehensive spectrum of molecular plant genetics and cell biology methods is taught. Students learn to evaluate which techniques are best suited to address different research questions. Genome editing techniques to generate transgenic plants and their impact on modifying gene functions to improve crop production are presented.
Novel plant model organisms from mosses and ferns are introduced to demonstrate how advanced plant molecular methods enable to investigate the evolution of molecular mechanisms that govern land plant adaptations to an ever-changing environment.

Content

LECTURE: A comprehensive Antirrhinum and Arabidopsis flower mutant collection is analysed to gain insight into key floral homeotic gene functions by analyses of loss-of function, gain-of-function and knock-down mutants and their impact for plant genetic studies and breeding applications.
SEMINAR: Regulatory control mechanisms exerted at the transcriptional level (e.g. cis/trans-regulatory changes, miRNA) and posttranslational modifications (e.g. redox-regulation, proteasome degradation, non-cell autonomy) affecting transcription factor activities together with hormone signalling pathways are presented. Students acquire an overview of different RNA-expression and protein interaction techniques, with the goal to discern their strengths and limitations.
EXERCISES: In the practical course, students work on their own, state-of-the art research project and gain insight into bioinformatics data analyses. They will expand their knowledge on how to design and conduct experiments as well as present, interpret and discuss their data in final presentations.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		Basic genetic and botany knowledge	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Oral presentation of a scientific research paper and stimulation of an interactive discussion	Basic genetic and botany knowledge	
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Participation in lectures

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Students require a basic knowledge in genetics and botany (bachelor level).

Identifier	**Module title**		**Courses language**
BIO-NMM-NBP	**Master Module Biophysics: NanoBioPhysics** *German module title* *Mastermodul Biophysik: NanoBioPhysik*		English
Module SWS (contact hours per week during semester) 8 SWS	**Module duration** 1 semester	**Authorized module representative** Lecturers in Biophysics	
Credit Points 12 CP	**Module frequency** Each summer term	**Committee responsible for the module** Fachbereichsrat Biologie/Chemie	

Learning objectives
LECTURE: The students obtain an interdisciplinary perspective of molecular cell biology covering biological, physical and chemical principles. They get a comprehensive, practice-oriented introduction into state-of-the-art techniques to clarify and manipulate molecular cell biology at the nanoscale using advanced, surface- and nanomaterial-based spectroscopic and microscopic techniques. EXERCISES: Students gain insights into interdisciplinary research and development in the field of Nanobiotechnology and deepen their methodological competence in the field of Nanobiophysics. SEMINAR: Convincing presentation of scientific data as well as critical perception is trained by a concluding meeting-like block seminar.

Content
LECTURE: "NanoBioPhysics: Interrogating and manipulating structure and function of biomolecules in cells": Physical and biological chemistry of the cell; fundamental spectroscopy, surface-sensitive and enhanced spectroscopic techniques; surface chemistry and micro-/Nano patterning techniques; colloidal nanoparticles; electron and fluorescence microscopy techniques; optical manipulation techniques; scanning probe microscopy and force spectroscopy.
SEMINAR: Critical discussion of research results in the field of molecular and cellular biophysics.
EXERCISES: Methods of molecular and cellular biophysics; advanced spectroscopic and microscopic techniques; Surface and nanoparticle (bio) functionalization and functional characterization.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Special scientific and methodological competences are tested for the partial aspects of biophysics as described under “contents”.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.
Prerequisites for Participation in this Module: Basic training in molecular cell biology and spectroscopy, good background in organic, inorganic and physical chemistry

Identifier	**Module title**	**Courses language**
BIO-NMM-BP1	**Master Module Biophysics: Biological Spectroscopy and Microscopy** *German module title* *Mastermodul Biophysik: Biologische Spektroskopie und Mikroskopie*	English

Module SWS (contact hours per week during semester)	**Module duration**	**Authorized module representative**
8 SWS	1 semester	Lecturers in Biophysics
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	Fachbereichsrat Biologie/Chemie

Learning objectives

LECTURE: Students acquire comprehensive methodological competences in the application of advanced fluorescence imaging techniques for life science research. They widen and deepen their knowledge in the field of molecular spectroscopy and optical microscopy with a focus on fluorescence techniques. They acquire an overview of advanced and super resolution imaging techniques and their capabilities and limitation with respect to tackling questions in molecular cell biology. They obtain fundamental insights into methods of image analysis and quantitative data evaluation. EXERCISES: Within small projects, students learn to tackle unsolved questions in molecular cell biology research by applying spectroscopic and microscopic methods as well as quantitative data evaluation including statistical analysis. SEMINAR: Convincing presentation of scientific data as well as critical perception is trained by a concluding meeting-like block seminar

Content

LECTURE: "Biological Spectroscopy & Microscopy: from fundamental concepts to the application of advanced techniques": Fundamental quantum mechanics of molecular vibronic and electronic states; Fundamental properties of electronic transitions; Fluorescence spectroscopy techniques; Single molecule fluorescence; Fundamental fluorescence microscopy; Advanced and super resolution fluorescence imaging techniques.

SEMINAR: Critical discussion of research results in the field of molecular and cellular biophysics.

EXERCISES: Application of advanced spectroscopy and microscopy in molecular and cellular biology as well as image analysis and quantitative data evaluation including statistical analyses.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.

2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Special scientific and methodological competences are tested for the partial aspects of biophysics as described under "contents".

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Basic training in molecular cell biology and light microscopy

Identifier	**Module title**		**Courses language**
BIO-NMM-BP2	**Master Module Biophysics: Fundamentals of Bioimaging and Data Processing** *German module title* *Mastermodul Biophysik: Grundlagen der biologischen Bildgebung und Datenbearbeitung*		English
Module SWS (contact hours per week during semester) 8 SWS	**Module duration** 1 semester	**Authorized module representative** Lecturers in CellNanOs: R. Kurre, K. Psathaki, S. Kunis	
Credit Points 12 CP	**Module frequency** Each summer term	**Committee responsible for the module** Fachbereichsrat Biologie/Chemie	

Learning objectives

LECTURE: Students are going to broaden and develop a deeper theoretical and experimental knowledge of light and electron microscopy as well as computer-based image and data processing. Focus of this module is the application of advanced imaging and analysis methods in the field of biological research. Students will gain profound expertise in assessing pros and cons of different methods.

SEMINAR: Students have to present and discuss state-of-the-art methods and/or their applications in biological research in the form of a scientific talk.

EXERCISES: Students are going to learn fundamentals of sample preparation, image/data acquisition and post processing on the basis of typical bioimaging projects.

Content
LECTURE: Light and fluorescence microscopy (Epi, cLSM, TIRFM, light-sheet, etc.), electron microscopy ((cryo) sample preparation, (3D) TEM, volume EM, CLEM, etc.), data management, optimization and processing (deconvolution, denoising, visualization, correlation techniques, etc.).
SEMINAR: Critical assessment of methods and research results in the field of bioimaging.
EXERCISES: Selection of advanced small projects of light and electron microscopy (LM/EM) with full workflows starting from sample preparation to data/image acquisition and final post processing. Exercises will be conducted in one single block (two weeks) by small groups. (LM & EM each one week)

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination on the contents of the module (usually 90 min.) or oral examination (usually 60 min.) as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Specific methodological competences based on module content will be assessed.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Basic knowledge of microscopy

Identifier	Module title	Courses language
BIO-NMM-BP3	**Master Module Biophysics: Signalling in Immunity and Cell Death** *German module title* *Mastermodul Biophysik: Signalwege von Immunität und Zelltod*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Biophysics
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

LECTURE: The students obtain a comprehensive introduction of molecular cell biology covering intra- and inter-cellular signalling relevant to cell death, inflammation and immunity. They get a detailed insight of the molecular mechanisms involved in the regulation of innate immunity as well as of cell death in response to physiological and infectious challenges, and a perspective of the consequent inflammatory and immune reactions as well as of their implications in chronic inflammatory diseases and cancer.
SEMINAR: Students learn the critical discussion and evaluation of research results.
EXERCISES: Students gain insights into the molecular determinants involved in cell death and intercellular-immunity signalling and develop competence in the monitoring and modulation of these processes at the molecular level.

Content

LECTURE: " Signalling in immunity and cell death: mechanisms of inter- and intracellular communication":
Innate and adaptive immunity; immune cells/haematopoiesis; immune cell communication; evolutionary origins of regulated cell death; cell death signalling and homeostasis; apoptosis and regulated necrosis; autophagy; cell death and metabolism; lipids in immunity and cell-death signal transduction; infection and inflammatory mechanisms; dysregulation and related oncogenic and inflammatory diseases; medical Implications.
SEMINAR: Critical discussion of research results in the field of molecular and cellular biology.
EXERCISES: Methods of molecular and cellular biology; molecular analysis of protein ligands and receptors; cell death induction and monitoring by biochemical, spectroscopic and microscopic techniques; infection assays and cell death/inflammatory read-out.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		Basic knowledge in cell biology and the immune system of vertebrates (Bachelor level)	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		

3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Specialized scientific competencies on the sub-aspects of biochemistry and molecular cell biology as described under "contents" are tested.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Basic module in cell biology at the bachelor level.

Identifier	Module title	Courses language
BIO-NMM-MB1	**Master Module Microbiology: Microbial Pathomechanisms** *German module title* *Mastermodul Mikrobiologie: Mikrobielle Pathomechanismen*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Microbiology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students expand and deepen their subject-specific scientific and methodological competences within the framework of a project work. Students are able to plan extensive series of laboratory experiments on a selected special topic area of microbiology and infection biology, carry out the experiments independently, evaluate the results and present them in writing. In doing so, they learn to take into account the relevant literature of the respective subject area. They train to understand and give presentations in English and they train to reflect critically on original scientific literature in English. They learn to summarise and present the results of their own project in the form of an English-language presentation.

Content

LECTURE: Microbial pathomechanisms and infection biology: infectious diseases (caused by viruses, bacteria, fungi, and parasites), pathogen-host interactions, virulence factors (toxins, adhesins, etc.), methods and model systems for infectious diseases research, cell invasion and intracellular lifestyle, immune evasion, evolution of virulence factors.

SEMINAR: Fundamentals of immunology and defence against infectious agents. Using selected chapters from the Janeway textbook 'Immunology', the structure and function of cells of the innate and adaptive immune system are discussed, the control of recognition 'self and foreign' and the regulation of immune responses. Basic methods of immunology are covered. Applications of -Omics approaches for study host-pathogen interactions are trained.

EXERCISES: Methods of molecular microbiology and infection biology: molecular and cell biological techniques, control mechanisms by bacterial effector proteins, invasion mechanisms, intracellular lifestyle, advanced bacterial genetics, light and electron microscopy in microbiology, single cell analyses, proteomics analyses.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4			Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Competence in microbiology aquired in the different parts of the module will be examined. This includes judgement of the quality of the oral presentation and participation in the seminars.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	Module title	Courses language
BIO-NMM-MZB	**Master Module Molecular Cell Biology: Cell Membranes: From Evolutionary Origins to Deciphering the Lipid Code** *German module title* *Mastermodul Molekulare Zellbiologie:Zellmembranen: Vom evolutionären Ursprung zur Entschlüsselung des Lipid-Codes*	English

Module SWS (contact hours per week during semester)	Module duration	Authorised module representative
8 SWS	1 semester	Lecturers in Molecular Cell Biology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students acquire in-depth knowledge of molecular processes that take place on and in cell membranes, as well as how these processes help to shape cell architecture and function. They also learn how these processes can be observed and analysed at the molecular level (see "contents"). They can transfer this knowledge to new circumstances and derive conclusions. They apply sophisticated chemical-biological and molecular-cell-biological working methods in the laboratory. The data collected experimentally with these methods are carefully analysed, evaluated with common statistical procedures, graphically presented and critically discussed. Additionally, the students acquire subject-specific and methodological contents from English-language review and specialist articles, research the literature important for the respective subject-specific environment, prepare a presentation for it and master the common rules of presenting scientific data. They reflect on and discuss the subject-related and methodological aspects of the respective topic and assess the quality of their own presentation as well as that of their fellow students. In doing so they apply the usual feedback rules.

Content

LECTURE: Key functions of cell membranes, historical perspectives of membrane organisation, evolutionary origin and biogenesis of cell membranes, co-evolution of lipids and proteins, the lipid code, lipid polymorphism, control of membrane stability and fluidity by cells, lipid landscapes and organelle identity, lipid transport and homeostasis, Golgi as lipid filter, lipid flippases, sensors and transfer proteins, how defects in lipid homeostasis lead to disease, experimental approaches to deciphering the lipid code.

SEMINAR: Presentation and discussion of milestone publications in molecular membrane biology.

EXERCISES: Techniques of molecular cell biology, cell culture, live-cell imaging, subcellular fractionation & immunoblotting, cell-free translation of membrane proteins in liposomes and their subsequent analysis, determination of protein-lipid interactions in living cells and in proteoliposomes with photo-activatable lipids, dissection of lipid signalling pathways in living cells with photo-caged and/or photo-switchable lipid analogues.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		Successful participation in the thematically corresponding in-depth lecture or participation in the corresponding basic module "Molecular Cell Biology".	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.

2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Special scientific competences are tested in the areas described under "contents of Molecular Membrane Biology".

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: General requirements are regulated by the respective valid examination regulations.

Identifier	**Module title**	**Courses language**
BIO-NMM-NB	**Master Module Neurobiology: Neurobiology** *German module title* *Mastermodul Neurobiologie: Neurobiologie*	English

Module SWS (contact hours per week during semester)	**Module duration**	**Authorized module representative**
8 SWS	1 semester	Lecturers in Neurobiology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students should acquire advanced scientific competences. They acquire in-depth knowledge of selected neurobiological topics (see "contents") and develop an understanding of neurobiological processes and connections. They can transfer this knowledge to new circumstances and deduce consequences. They apply more sophisticated laboratory, biochemical, molecular biological, cell biological and electrophysiological working methods. The data experimentally collected with these methods are carefully analysed, evaluated with the usual statistical methods, graphically presented and critically discussed. The students develop professional and methodological content from English-language articles, research literature relevant to the respective professional environment, prepare a presentation and master the common rules for presenting scientific data. They reflect and discuss the

technical and methodological aspects of the respective topic and assess the quality of their own presentation and that of their fellow students. They use the usual feedback rules.

Content

LECTURE: Systemic Neurobiology (Development and Anatomical Organization, Autonomic Nervous System, Sensory Perception, Motor Systems, Neuronal Foundations of Cognitive Performance, Awareness, Sleep and Systemic Diseases of the Nervous System).
SEMINAR: With the help of primary literature in-depth technical and methodological theoretical knowledge in the field of systemic neurobiology will be developed.
EXERCISES: Methods of molecular and systemic neurobiology: Gene transfer and life cell imaging of neural cells, identification and analysis of transgenic mice, electrophysiological recordings of brain slices.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Special scientific competencies for the sub-aspects of neurobiology as described under “content” are examined.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	Module title	Courses language
BIO-NMM-ÖK1	**Master Module Ecology: Experimental Ecology and Evolution** *German module title* *Mastermodul Ökologie: Experimentelle Ökologie und Evolution*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Ecology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	Fachbereichsrat Biologie/Chemie

Learning objectives

This module focusses on two main aspects. First, it will highlight the experimental power of using laboratory-based model systems to address fundamental questions in ecology and evolution. Second, it will introduce participants to the scientific process. In particular, populations and communities of unicellular organisms are employed to experimentally answer certain scientific questions. For this, the lecture series will provide the relevant background information. In the seminar, participants will select their own topic in the field of experimental ecology and evolution and present a talk to the whole group. Afterwards, both the scientific content as well as the style of the presentation itself is discussed. In this way, course participants will improve their skills to present complex scientific matters and to provide constructive feedback. In the practical course, participants will form small groups, read the relevant literature and - based on this - develop their own research hypothesis. The resulting hypothesis will then be tested in dedicated experiments, which have been designed and planned by the different groups. Afterwards, the collected data will be statistically analysed and graphically displayed. In this way, course participants will gain hands-on experience with the scientific process from developing a hypothesis to presenting the final result. During this course, students will not only extent their theoretical knowledge and acquire new methodological skills, but also learn how to summarize and communicate scientific results in an effective manner. Finally, course participants will improve their skills to discuss the work of others in a critical and constructive manner.

Content

LECTURE: Four main topics will be covered:

(1) How do organisms adapt to their environment?
(2) Which selection pressures result from interactions with other organisms?
(3) How do I statistically analyse scientific data?
(4) How does science work?

SEMINAR: The seminar will extend and deepen the aspects treated in the lecture. Course participants will select their own topic of interest, search for and read the relevant literature, and present the topic as a talk. Subsequently, both the content of the talk and the style of presentation will be discussed.

EXERCISES: A scientific project will be developed and performed to verify a previously-defined hypothesis. Projects will use microbial model systems to address fundamental questions in ecology and evolution.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.

2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocol or poster presentation. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Knowledge on selected topics acquired during the lecture

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	**Module title**	**Courses language**
BIO-NMM-ÖK2	**Master Module Ecology: Theoretical Ecology and Evolution** *German module title* *Mastermodul Ökologie: Theoretische Ökologie und Evolution*	English

Module SWS (contact hours per week during semester)	**Module duration**	**Authorized module representative**
8 SWS	1 semester	Lecturers in Ecology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

Scientific competencies: In this course, students learn conceptual and technical methods that are applied in evolutionary theory and theoretical ecology. With the help of mathematical models and computer simulations, the students expand their knowledge to analyse and evaluate scientific hypotheses. Both techniques allow them to generate null models, expectations, and precise scientific predictions. Some of the most fundamental biological questions, such as B. the evolution of cooperation, the origin of life, and the evolution of multicellular organisms, are researched with the help of mathematical models. Many complex processes in the areas mentioned above can be explained with the help of mathematical models. For this reason, creative thinking and problem-oriented solution strategies will be necessary in this course in order to understand fundamental issues in biology.

Methodical skills: The conceptual approaches of the theory of evolution (including population genetic issues and the application of game theory in questions of evolutionary biology) and theoretical ecology (including issues of population ecology, interaction, and mutualism of species, predation, competition, etc.) are examined with the help of mathematical models and computer simulations. No previous knowledge is required, neither in mathematics nor in computer programming. The necessary application methods are developed in close connection with conceptual mathematical questions.

Content

LECTURE: Deterministic and stochastic models of population growth, classical ecological models of interacting populations, models of spatial interactions, stability and biodiversity of ecological communities, evolutionary dynamics, evolutionary game theory, payoff matrix, evolutionary stable strategy (ESS), evolutionary games: Coward's Game, Prisoner's Dilemma, War of Attrition, Rock-Scissors-Paper, Signal Theory and Handicap Principle, Coevolution, Replicator Equation, Adaptive Dynamics and Evolutionary Invasion Analysis, Classical Population Genetic Models, Horizontal Transmission: application to horizontal gene transfer, Epidemiology, Evolution of Culture and the Evolution of Languages.

SEMINAR: Further in-depth study of aspects of the lecture.

EXERCISES: Analytical approaches and computer simulations to model ecological and evolutionary biological processes.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination on the contents of the module (usually 90 min.) or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Knowledge on selected topics acquired during the lecture

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	**Module title**		**Courses language**
BIO-NMM-PP	**Master Module Plant Physiology** *German module title* *Mastermodul Pflanzenphysiologie*		English
Module SWS (contact hours per week during semester) 8 SWS	**Module duration** 1 semester	**Authorized module representative** Lecturers in Plant Physiology	
Credit Points 12 CP	**Module frequency** Each winter term	**Committee responsible for the module** Fachbereichsrat Biologie/Chemie	

Learning objectives

The students expand and deepen their scientific and methodical competences. They can plan experimental series for selected subject areas, carry out the experiments independently, evaluate the results and present them in a written report. They learn about the relevant and current literature of the topic. They train understanding and delivering presentations in English as well as the critical reflection of original scientific literature. They will learn to summarise and present the results of their own projects in English presentations.

Content

LECTURE: Selected chapters from various areas.
SEMINAR: With the help of review articles and primary literature, in-depth technical and methodological-theoretical knowledge from different sub-areas will be acquired.
EXERCISES: Selected experiments from different areas.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written or MC examination on the contents of the module (usually 90 min.), oral examination, lab reports or presentation as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, uninterupted and active participation in the seminar is required.		

3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, uninterrupted and active participation in the exercises is required.		

Examination requirements: Knowledge on selected topics acquired during the lecture

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	Module title	Courses language
BIO-NMM-SB	**Master Module Structural Biology** *German module title* *Mastermodul Strukturbiologie*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Structural Biology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students expand their scientific and methodological competences in the field of structural biology. They receive an in-depth overview of the methods widely used in structural biology and their areas of application based on examples. They learn the theoretical background of the respective methodology and thus acquire in-depth knowledge of structural biology. The students implement what they have learned in a series of experiments and learn to carry out the evaluation independently, as well as to present the results in writing. They train to understand and give presentations in English and critically reflect on original scientific literature. They consider and discuss technical and methodological aspects of structural biology and assess the quality of their presentation as well as that of their fellow students.

Content

LECTURE: Methods of structural biology, design and function of the transmission electron microscope, sequence and steps of single particle analysis and tomography. Protein folding motifs, protein interaction and complex formation, conformations and dynamics. Macromolecules in a cellular context.
SEMINAR: Presentation and discussion of relevant literature in English.
EXERCISES: Techniques of structural biology. Sample preparation and data acquisition of samples relevant to structural biology. Analysis and processing of collected data, as well as their analysis and presentation.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Written examination or MC on the contents of the module (usually 90 min.) or oral examination or protocol or presentation as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.		

Examination requirements: Knowledge on selected topics acquired during the lecture

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	Module title	Courses language
BIO-NMM-ZO1	**Master Module Zoology: Molecular Developmental Biology** *German module title* *Mastermodul Zoologie: Entwicklungsgenetik*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Zoology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students will acquire advanced scientific competences, and an in-depth knowledge of selected topics in molecular developmental biology. During the practical course, they will be trained in sophisticated laboratory techniques, including biochemistry, molecular biology, cell biology, advanced microscopy and developmental biology. The students will be trained in reading English-language literature, to obtain technical and methodological knowledge from primary literature. They will be researching additional literature, and prepare a journal club presentation to master the basic rules of presenting scientific data. They will reflect and discuss the technical and methodological aspects of the aspects of the respective topic.

Content

LECTURE: The lecture will discuss the molecular and cellular mechanisms of Drosophila melanogaster development. Topics include: morphogen gradients, molecular mechanisms of axis formation, segmentation, organ formation, RNA-interference, CRISPR, fluorescent life cell markers (e.g. GFP), transgenic Drosophila.

SEMINAR: We will read, revise and discuss recent research papers. Presentation skills, preparing a keynote seminar, in-depth technical and methodological knowledge in the field of developmental biology will be developed with the help of current literature.

EXERCISES: Methods of molecular and cellular developmental biology: biochemical, molecular, cell biological and microscopic techniques, including fluorescence microscopy. Examples for experiments: Expression of various proteins in insect cells and further analysis by Western blot, analysis of fluorescent subcellular markers from Drosophila transgenic lines by microscopy and Western blot, localization of transposon insertions in the genome of Drosophila transgenic lines by PCR and other molecular biology methods, Hybridization techniques - in situ hybridization to detect gene-specific mRNAs in tissues and embryos, ectopic expression of subcellular markers with Gal4 driver lines, immunohistochemically detection of reporter gene expression, introduction to fluorescence microscopy and photo documentation.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4			Written examination or MC exam on the contents of the module (usually 90 min.) or oral examination or protocol or presentation as specified by the lecturer at the beginning of the course.

2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.	Erweiterungsmodul Genetik I or equivalent courses in genetics, cell biology or biochemistry Please consult us if you are unsure whether you meet the requirements.	

Examination requirements: Developmental biology topics as described under “contents” will be tested.

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: If you have a good background in genetics, but have not taken our undergraduate module Genetics I, please prepare for the present module, using a series of OpenCast lectures (provided by us) to catch up on the basics in Drosophila biology. The lectures are part of our Bachelor module (Erweiterungsmodul) Genetics I, which is currently jointly organized by the Departments of Genetics and Zoology. The topics, covered in these lectures, constitute a mandatory prerequisite to qualify for our Master module. If you have no or little training in genetics and/or basic Drosophila (developmental) biology, it is essential that you catch up on these topics before the start of the master course. Participation to the course will only be granted after passing a mandatory entry test. The test will be graded, and you can use the result to improve the overall grade for the module. This module is designed as an "Advanced Course" and cannot be taken by biology novices under any circumstances.

Identifier	Module title	Courses language
BIO-NMM-ZO2	**Master Module Zoology: Developmental Biology and Molecular Genetics of Marine Organisms, at the "Biologische Anstalt Helgoland"** *German module title* *Mastermodul Zoologie: Entwicklungsbiologie und Molekulargenetik mariner Organismen, an der "Biologischen Anstalt Helgoland"*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Zoology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Lecture each winter term, seminar and exercises each summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students will acquire knowledge on selected developmental biological processes of marine organisms. Thereby will be trained in and apply more demanding laboratory biochemical, molecular biological, cell biological and microscopic techniques, and learn how to obtain and revise technical and methodological contents from articles in English and prepare the contents of the articles in a journal club presentation.

Content

LECTURE: Students have two options:
Option 1: Attendance on the Marine Biology lecture (Meeresbiologie) read in the winter term (written exam).
Option 2: Attendance on another lecture on basic genetics or cell biology (basically anything from the MSc Cell and Molecular Biology program) (written exam). Please make sure to check with us if the chosen lecture is creditable for our course.
SEMINAR: Presentation of a scientific publication of developmental biology of marine organisms in a journal club presentation.
EXERCISES: The practical course will take place at the “AWI Biologische Anstalt Helgoland”. We will preferentially work with sea urchins and sea squirts. Students will be trained in, and perform, various techniques in the field of developmental biology. These include for example: (i) Fertilization of sea urchin and sea squirt eggs, detection of cortical granules, effects of ECM proteases on development, (ii) tissue differentiation (enzyme histochemistry, antibody staining, SDS gel electrophoresis, immuno-blot, skeletal differentiation), fluorescence microscopy, video microscopy, and (iii) Comparative gene expression (PCR analysis of taxonomically selected organisms, RT-PCR for gene expression analysis, in situ hybridization). In addition, students will learn about non-university research institutes. In addition to laboratory work, zoological field trips will be carried out.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4			Written examination or MC exam on the contents of the module (usually 90 min.) or oral examination or protocol or presentation as specified by the lecturer at the beginning of the course.

2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.	Takes place on Helgoland.	
3rd Component:					
Exercises	5	6	Approved extended protocols. Since content and skills relevant to the study and profession must be acquired and practiced, regular active participation in the exercises is required.	Takes place on Helgoland and only master's students majoring in cell and molecular biology are eligible to participate. Students of other majors may participate only after personal approval by the module supervisor.	

Examination requirements: Written exam on the topic of the selected lecture

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module: Only master's students majoring in cell and molecular biology are eligible to participate. Students of other majors may participate only after personal approval by the module supervisor.

Identifier	**Module title**	**Courses language**
BIO-NMM	**Master module (general description)** *German module title* *Mastermodul (allgemeine Beschreibung)*	English

Module SWS (contact hours per week during semester)	**Module duration**	**Authorized module representative**
8 SWS	1 semester	Lecturers in Biology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Winter or summer term	Fachbereichsrat Biologie/Chemie

Learning objectives

The students expand and deepen their subject-specific and methodological competences. They can plan more extensive series of experiments on selected, special topics; carry out the experiments independently; evaluate the results and present them in writing. In doing so, they learn to consider the relevant and current literature of the respective subject area. They train to understand and give presentations in English and critically reflect on original scientific literature in English. You will learn to summarise and present the results of your own projects in the form of English-language presentations. The literature work associated with the exercises in the style of a short scientific publication requires

independent research as well as a targeted examination of the respective subject-related content and thus leads towards the later final thesis.

Content

LECTURE: Selected chapters from different sub-areas.
SEMINAR: With the help of reviewing articles and primary literature, in-depth technical and methodological-theoretical knowledge from different sub-areas is acquired.
EXERCISES: Selected experiments from different sub-areas.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4			Written examination or MC exam on the contents of the module (usually 90 min.) or oral examination or protocol or presentation as specified by the lecturer at the beginning of the course.
2nd Component:					
Seminar	1	2	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		
3rd Component:					
Exercises	5	6	Approved protocols and an additional literature paper of about 8-10 pages (approx. 1,200 characters per page). Since study and professionally relevant contents and skills must be acquired and practised, regular participation in the exercises is required.		

Examination requirements: Written exam on the topic of the selected lecture

Calculation of module grade, where applicable: Grade of examination

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" in the major or minor subject Biology. For students of other study programmes or students who have changed their place of study and are new in Osnabrück, only after personal consultation with the person responsible for the module. Admission/participation is then only possible after consultation with the lecturer and proof of the required prior knowledge. All students need a basic knowledge of the respective subject at Bachelor level.

Prerequisites for Participation in this Module:

Identifier	Module title	Courses language
BIO-FS1/BIO-FS2	**Professional Specialization 1 / Professional Specialization 2** *German module title* *Fachliche Spezialisierung 1/ Fachliche Spezialisierung 2*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	At least 5 weeks each	Lecturers in Biology
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP each	By individual arrangement	Fachbereichsrat Biologie/Chemie

Learning objectives

Acquisition of an in-depth subject and methodological competence in a selected special field of biology through practical studies under supervision.

Content

Practical, mostly experimental work on a bioscientific problem from the current research areas of the biology working groups.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
In each case, full-day laboratory work totalling at least 5 weeks or comparable field work.	4 each	6 each	Project report	none	
2nd Component:					
3rd Component:					

Examination requirements: none

Calculation of module grade, where applicable: none

Guidelines for passing the module, where applicable: All course certificates must have been obtained.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" for the Major or Minor in Biology

Prerequisites for Participation in this Module:

Identifier	Module title	Courses language
BIO-FB	**Research Course** *German module title* *Forschungsarbeit*	English

Module SWS (contact hours per week during semester)	Module duration	Authorized module representative
7-9 SWS	1 semester	Lecturers in Biology
Credit Points	**Module frequency**	**Committee responsible for the module**
18 CP	Each academic year by individual arrangement	Fachbereichsrat Biologie/Chemie

Learning objectives

Within the framework of the research paper, students should demonstrate that they are able to work on a defined biological problem, from the development of the research question to data evaluation and discussion, in a scientifically and methodologically correct and independent manner within a specified period of time. This is particularly professionally qualifying.

Content
Independent practical, mostly experimental work on a bioscientific problem from the current research areas of one of the biology working groups. The research work prepares the practical part of the Master's thesis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Laboratory and/or field work and self-study	7-9	18		none	The research paper is assessed together with the Master's thesis by two surveyors.
2nd Component:					
3rd Component:					

Examination requirements: none

Calculation of module grade, where applicable: Grade of the Master´s Thesis

Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.

Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14

Module Applicability: MSc "Nanosciences" for the Major or Minor in Biology

Prerequisites for Participation in this Module: none

Identifier	**Module title**	**Courses language**
BIO-SPV	**In-Depth Lecture** *German module title* *Spezialvorlesungsmodul*	German or English

Module SWS (contact hours per week during semester)	**Module duration**	**Authorized module representative**
2 SWS	1 semester	Lecturers in Biology
Credit Points	**Module frequency**	**Committee responsible for the module**
4 CP	Each academic year	Fachbereichsrat Biologie/Chemie

Learning objectives
Acquisition of specialised scientific competences. Acquisition of specialised knowledge of selected biological processes; development of an understanding of biological processes and interrelationships. Recognising biological principles and transferring them to new situations.

Content
Selected current topics from different biological subfields

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Special non-modular lectures from the extended range of biology or a lecture decoupled from a Master's module.	2	4	none	none	Written examination or MC exam on the contents of the module (usually 90 min.) or oral examination or protocol or presentation as specified by the lecturer at the beginning of the course.
2nd Component:					

3rd Component:					
Examination requirements: Specialised scientific competences on selected current topics in biology are examined.					
Calculation of module grade, where applicable: Grade of examination					
Guidelines for passing the module, where applicable: All course certificates must have been obtained; the course-related examination must have been passed with a grade of at least 4.0.					
Retaking examinations to improve grades, where applicable: According to the general rules of examination (allgemeine Prüfungsordnung) gem. § 14					
Module Applicability: MSc "Nanosciences" for the Major or Minor in Biology, MSc Biology					
Prerequisites for Participation in this Module: none					

Chemistry
Preface

The present module descriptions of Chemistry are based on the specifications of the General Examination Regulations for Bachelor's and Master's Programs (APO) of the University of Osnabrück.

In the module descriptions, the following abbreviations are used for the forms of course-related examinations mentioned in § 10 APO:

a) Term paper	HA	
b) Oral examination	mP	(time in minutes)
c) Presentation	Ref	(time in minutes)
d) Oral presentation	RefmA	(time in minutes)
e) Written exam	K	(time in minutes)
f) Multiple-choice exam	MCK	(time in minutes)
g) Study project	SP	

The following further forms of study-accompanying examinations are intended:

h) Seminar presentation SV (time in minutes)
In a seminar presentation, the candidate should demonstrate that he/she is familiar with the scientific basics, the state-of-the-art in science as well as the scientific contexts of the examination area. As well as, that he/she is able to present and discuss these orally in a suitable manner in front of a specialist scientific audience. The seminar lecture can take place in public at the university according to the examiner's decision. The form and duration of the seminar presentation will be in accordance with the requirements of the module description.

i) Poster presentation PP (time in minutes)
In a poster presentation, the candidate should demonstrate that he/she is familiar with the scientific principles, and the scientific contexts of the examination field and that he/she is able to present and discuss them orally in a suitable manner with the aid of the poster in front of a specialist scientific audience. The poster presentation can take place in public at the university according to the examiner's decision. The form and duration of the poster presentation will depend on the specifications of the module description.

A slash ("/") between two or more course-related forms of examination means that they are available for selection. The lecturer(s) will announce at the beginning of the module/component which form of examination will be used in the current case.

The topics indicated in the module descriptions under “Contents” are to be regarded as guidance for the lecturers and students and are based on a course period of 15 weeks. Deviations in the scope of the learning content taught will inevitably result from the varying length of the course period in a semester and from the varying location of holidays in a semester. In addition, the selection, methodological design and depth of detail of the topics listed under content are subject to Art. 5 Para. 3 Sentence 1 GG (freedom of science, research and teaching).

Compulsory attendance

For reasons of health and safety, attendance is compulsory at the seminars on the practical courses in chemistry. Participation in the practical course without attending the seminar is not possible. Furthermore, it goes without saying that practical experience and knowledge can only be acquired through active participation in the practical course, which is why compulsory attendance is also a prerequisite for passing the practical course.

Identifier	Module title
CHE-Supra	**Supramolecular Chemistry**
	German module title *Supramolekulare Chemie*

Module SWS (contact hours per week during semester)	**Module duration**	**Authorised module representative**
5 SWS	1 semester	Lecturers of Organic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives

Students will obtain structured expert knowledge on intermolecular interactions based on advanced theories of weak and non-covalent bonds. This includes knowledge of important supramolecular compound classes and structures. The goal is to enable students to understand nanomolecular, functional, and switchable systems, e.g. molecular machines, rotors, shuttles, and photonic devices. By comparing natural and synthetic catalysts and membrane transporters, the students will be enabled to recognize and discuss similarities and differences of supramolecular and biomolecular systems. Within the accompanying lab course, the students will receive a hands-on training in supramolecular, optical-spectroscopic characterization methods, they will learn to make scientific hypotheses, and how to address them. The seminar of this module includes advanced topics, which are partly related to the experiments of the lab course and, in the other part, provide an insight into contemporary and seminal original research from the scientific literature.

Content

Theory of weak, non-covalent, intermolecular interactions: ion-ion, ion-dipole, dipole-dipole, induction and dispersion interactions, hydrogen bonds, the hydrophobic effect, fluorophilicity, cation-π and anion-π-interactions, aromatic electron donor-acceptor interactions, halogen bonding. Molecular recognition of host-guest complexes (crown ethers, cyclodextrins, calixarenes, cucurbiturils, and others) and methods for the determination of binding thermodynamics and kinetics (NMR, isothermal titration calorimetry, optical-spectroscopic methods). Dynamics of supramolecular systems and dynamic covalent chemistry. Supramolecular topology (catenanes, rotaxanes, and molecular knots). Selfassembly. Functional and switchable supramolecular systems and machines. Supramolecular photochemistry. Biomimetic chemistry of biomembranes and membrane transporters, and supramolecular catalysis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: SupraV					
Lecture	2 SWS	3 CP	none	Participation in exercises, passing 50 % of the exercise tasks, presentation, report of practical course	K (120) / mP (30)
2. Component: SupraÜ					
Exercise	1 SWS	1 CP	Solving the exercises, presentation	none	included in lecture
3. Component: SupraPrac					
Practical course	2 SWS	2 CP	Written protocols; compulsory attendance	none	none

Examination requirements

- Content and qualification aims of the module

Calculation of module grade, where applicable
- Grade of the course-related exams

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier	Module title
CHE-FunP	**Functional Polymers**
	German module title *Funktionelle Polymere*

Module SWS (contact hours per week during semester)	**Module duration**	**Authorised module representative**
10 SWS	2 semesters	Lecturers of Organic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives

It is the students to recognize that functional polymers are macromolecules that exhibit special properties in addition to their function as materials. The module treats the preparation of synthetic macromolecules, and describes examples from the diverse world of functional polymers.

Content

Lecture, Part 1: Synthesis

Step growth reactions (Flory-principle, linear, crosslinked step-growth, Flory - Stockmeyer), chain growth reactions: free radical polymerization, emulsion polymerization, controlled radical polymerization (nitroxide mediated, ATRP, RAFT), copolymerization (terminal model, copolymerization diagrams, sequences, Q-e-scheme), cationic polymerization, ring-opening cationic polymerization, anionic polymerization (mechanism, Poisson-distribution, effect of counter-ions and solvents, Winstein-spectrum, block copolymers), coordinative polymerization (Ziegler-Natta-, Phillips-, Metallocene-Catalysts, ROMP), rapid injection moulding, thermoplastic elastomers, rubber (entropy elasticity, vulcanization chemistry).

Lecture, Part 2: Materials and Applications

Type and applications of special synthetic polymers: Membranes (porous membrane preparation via track-etching, polymer stretching, TIPS, SIPS, membrane materials, separation processes: microfiltration, ultrafiltration, hyperfiltration, non-porous membranes: materials, solution-diffusion mechanism of separation, gas separations, pervaporation, membrane reactors), high temperature resistant polymers (materials, synthesis, performances), photo conducting polymers, self organization, polymeric liquid crystals (phases, materials, properties), Dendrimers and hyperbranched polymers, polyelectrolytes (materials, applications), non ionic, water soluble polymers (PEO, PVA, PVAm, NVP) glues.

Practical course

Participation in current research work on polymer synthesis and / or modification in the Department of Organic Materials Chemistry.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: FunP SynthesisV					
Lecture	2 SWS	3 CP	none	Participation in exercises, report of practical course	K (90)

2. Component: FunP SynthesisÜ					
Exercise	1 SWS	1 CP	Processing of exercise tasks	none	included in component 1 lecture
3. Component: FunP Materials and ApplicationsV					
Lecture	2 SWS	3 CP	none	none	K (90)
4. Component: FunP Prac					
Practical course	5 SWS	5 CP	Compulsory attendance; conducting experiments; written protocols of the experiments	none	none

Examination requirements
- Content and qualification aims of the module

Calculation of module grade, where applicable
- Grade of the course-related exams or average grade of all course-related exams.

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier
CHE-Nano

Module title
Nanomaterials

German module title
Nanomaterialien

Module SWS (contact hours per week during semester)	**Module duration**	**Authorised module representative**
10 SWS	2 semesters	Lecturers of Inorganic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives
Students acquire a detailed structured special knowledge regarding the synthesis methods and the particle size-dependent properties of nanocrystalline solids. Based on the model concepts on the subject, abstract thinking is promoted; in the accompanying practical course the working out and solving of scientific questions is promoted and practised.

Content
Lecture 1: Properties of nanocrystalline solids
Optical and electronic characteristics of nanocrystals from semiconductors, metals, and doted isolators; magnetic properties of nanocrystals, supra paramagnetism.
Lecture 2: Synthesis of nanocrystalline solids
Theories on nucleation, nucleation in solution, supersaturation, growth in solution, Ostwald Ripening, „focussing“ of particle size distribution, thermodynamic and kinetic control of growth, control of crystallite shape, surface ligands, electrostatic and steric stabilization of colloids.

Practical training:
Synthesis of nanocrystalline semiconductors, metals or doped isolators in solution and application of different characterization methods, such as X-ray powder diffractometry, transmission electron microscopy, dynamic light scattering, UV-Vis-absorption spectroscopy, FTIR spectroscopy, fluorescence spectroscopy, thermogravimetry.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method)
1. Component: Nano Properties of nanocrystalline solidsV					
Lecture	2 SWS	3 CP	none	none	K (120) / 2xK (60) / MCK (90) / 2xMCK (45) / mP (60) / 2xmP (45)
2. Component: Nano Properties of nanocrystalline solidsÜ					
Exercise	1 SWS	1 CP	Processing of exercise tasks	none	included in component 1 lecture
3. Component: Nano Synthesis of nanocrystalline solidsV					
Lecture	2 SWS	3 CP	none	none	K (120) / 2xK (60) / MCK (90) / 2xMCK (45) / mP (60) / 2xmP (45)
4. Component: Nano Prac					
Practical course	5 SWS	5 CP	Compulsory attendance; conducting of the experiments; written protocols or oral presentation of the results.	none	none

Examination requirements
- Content and qualification aims of the module

Calculation of module grade, where applicable
- Grade of the course-related exams or average grade of all course-related exams.

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier
CHE-Self

Module title
Self-Organizing Systems

German module title
Selbstorganisierende Systeme

Module SWS (contact hours per week during semester)	Module duration	Authorised module representative
5 SWS	1 semester	Lecturers of Physical Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives

The students acquire knowledge of structure formation processes that are coupled with self-organization. They will explore the potential of such structure formation processes for the production of functional materials. By elaborating interactive content modules related to the topic of the module, the students will train how to become acquainted with new scientific areas. They will practice literature research, scientific writing, structuring and summarizing of scientific problems as well as correct referencing.

Content

Nature of self-organized processes and their physical fundamentals; syntheses based on self-organization; structure formation by self-organization; characterization of self-organized structures by microscopy, scattering methods and image analysis; examples of self-organization.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: Seminar on Study project					
Seminar on Study project	3 SWS	4 CP	none	1) Elaboration of an interactive content module on a scientific problem related to the topic of the module 2) Participation in the laboratory course and written protocols of all experiments	SP / Ref (45) / RefmA (45) / mP (30) / K (60) / MCK (60)
2. Component: Laboratory course with seminar					
Seminar	2 SWS	2 CP	Compulsory attendance; processing of experiments; experimental protocols	none	none

Examination requirements

- Content and qualification aims of the module

Calculation of module grade, where applicable

- Grade of the course-related exams

Guidelines for passing the module, where applicable

- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable

- According to §14 APO

Module Applicability

- MSc Nanosciences

Prerequisites for Participation in this Module

- none

Identifier	Module title
CHE-Porous	**Porous Materials**
	German module title *Poröse Materialien*

Module SWS (contact hours per week during semester) 5 SWS	**Module duration** 1 semester	**Authorised module representative** Lecturers of Organic Chemistry
Credit Points 6 CP	**Module frequency** Each academic year	**Committee responsible for the module** Faculty council of Biology/Chemistry

Learning objectives

In this lecture, microporous materials will be introduced. Microporous materials represent a versatile class of materials which includes systems with different chemical structures. Zeolites, metal organic frameworks (MOF) and porous conjugated organic polymer belong to this class of material. Their synthesis as well as applications will be discussed. The theory of porosity and the characterization using gas physisorption isotherms will be part of the lecture. Characterization methods such as (powder) X-ray diffraction ((P)XRD), energy dispersive X-ray spectroscopy (EDX) and photoelectron spectroscopy such as XPS, are valuable tools in material analysis and will be part of the lecture.

In the seminar, students are given the opportunity to recapitulate their new acquired knowledge of porous polymers and characterization methods by exercises. The other part of the seminar is related to the experimental part of the module. We will discuss in detail what polymers will be synthesized and how to work with schlenk technique and autoclaves.

Within the accompanying lab course, the students will synthesize ionic microporous polymers and characterize by powder x-ray diffraction (PXRD) among others.

Content

Theory of porosity; zeolites metal organic frameworks¸ conjugated microporous polymers; ionic microporous polymers; applications of those polymers in the field of gas storage, e.g. hydrogen storage for fuel cells or gas separation, catalysis, storage and conversion of energy, e.g. as polyelectrolyte in lithium ion batteries or as ion exchangers for water softening in detergents or in wastewater treatments, biological applications due to antibacterial activity; characterization methods such as physisorption, (powder) X-ray diffraction ((P)XRD), energy dispersive X-ray spectroscopy (EDX) and photoelectron spectroscopy such as XPS.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: PorousV					
Lecture	2 SWS	3 CP	none	none	K (60) / mP (45)
2. Component: PorousÜ					
Exercise	1 SWS	1 CP	Exercise tasks; compulsory attendance	none	included in lecture
3. Component: PorousPrac					
Practical course	2 SWS	2 CP	Written protocols; compulsory attendance	Ref (30)	none

Examination requirements

- Content and qualification aims of the module

Calculation of module grade, where applicable

- Grade of the course-related exams

Guidelines for passing the module, where applicable

- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier	Module title
CHE-Biocon	**Bioconjugates**
	German module title *Biokonjugate*

Module SWS (contact hours per week during semester)	**Module duration**	**Authorised module representative**
2 SWS	1 semester	Lecturers of Organic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
2 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives

Students will obtain in this interdisciplinary course a structured knowledge on the synthesis and application of bioconjugates. They will learn how different functional groups can be used to connect peptides, proteins, DNA, and other biomolecules with synthetic materials such as dendrimers, fluorescent dyes, or different types of nanoparticles. They will learn how functional group selectivity can be controlled by choosing appropriate reagents and reaction conditions, and how the resulting bioconjugates can be purified. In the second part, students will learn how bioconjugates are used in analytical procedures called “assays” to determine the presence of a particular analyte, a certain biological activity, or a biomolecular property. The typical scientific instrumentation and assay design principles will be covered, the influence of binding equilibria of biomolecular interactions and enzyme kinetics will be discussed, and the students will obtain skills to critically assess data quality and the reliability of mechanistic models.

Content

Structure of biomolecules and the reactivity of major functional groups used in bioconjugation (amines, thiols, aldehydes). Reagents and mechanisms of bioconjugate reactions. Introduction of fluorescent, radioactive, and other labels to biomolecules. Biotinylation and the strept(avidin)-biotin system. Functionalization of polymer, gold, and silica particles and the DLVO theory. Chromogenic and fluorogenic probes. Fluorescence resonance energy transfer probes. Dye-antibody and enzyme-antibody conjugates for immunoassays. Theoretical basis and instrumentation for ligand binding and enzyme assays (absorption and fluorescence spectroscopy, radioactivity, and surface plasmon resonance), potential sources of error and how to avoid them. Data evaluation and statistical analysis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: BioconV					
Lecture	2 SWS	2 CP	none	none	K (60) / mP (30)

Examination requirements
- Content and qualification aims of the module

Calculation of module grade, where applicable
- Grade of the course-related exams

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier	Module title
CHE-FS1	**Professional Specialization 1**
	German module title *Fachliche Spezialisierung 1*

Module SWS (contact hours per week during semester)	**Module duration**	**Authorised module representative**
5 SWS	1 semester	Lecturers of Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives
Students acquire advanced knowledge and methodological competence in a specialized research topic in chemistry by studying relevant literature.
Self-competences such as time management, initiative, perseverance, tenacity, etc.

Content
The module aims to deepen the already known procedures in the treatment of original literature, starting from the search for literature, compilation of original literature, its interpretation up to its classification by bringing it together in a written report. Guided by a teacher of the special field, the students should independently deepen their knowledge in this special field. The choice of literature should be based on the master's thesis planned for the next semester in this special field, since the module serves as conceptual preparation for the master's thesis. Guidance is provided by the supervisor of the master's thesis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: FS1 Self-study					
Self-study	4 SWS	5 CP	Consistent participation in the seminar and frequent communication with the supervisor		SV (30) / RefmA (30) / mP (30)
2. Component: FS1 Seminar					
Seminar	1 SWS	1 CP	Consistent participation in the seminar and frequent communication with the supervisor		included in 1st Component

Examination requirements
- none

Calculation of module grade, where applicable
- Grade of the written report

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier	Module title
CHE-FS2	**Professional Specialization 2**
	German module title *Fachliche Spezialisierung 2*

Module SWS (contact hours per week during semester)	**Module duration**	**Authorised module representative**
5 SWS	1 semester	Lecturers of Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP	Each academic year	Faculty council of Biology/Chemistry

Learning objectives
Students acquire advanced knowledge and methodological competence in a specialized research topic in chemistry via the performance of established chemical experiments and characterization methods. Self-competencies such as time management, initiative, perseverance, tenacity, etc. are developed.

Content
The module is intended to deepen the already known procedures in handling chemicals, performing advanced experiments, and to deepen the knowledge on the preparation of spectra and other sources of information to characterize the products produced. Guided by an instructor, the students will independently learn the special experimental techniques, theoretical background, and characterization methods in this special field through independent study. The selection of experiments and characterization methods should be based on the master thesis planned for the next semester in this special field, since the module is intended to serve as experimental and theoretical preparation for the master thesis. Guidance will be provided by the supervisor of the master thesis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: FS2 Self-study					
Self-study	4 SWS	5 CP	Consistent participation in the seminar and frequent communication with the supervisor		SV (30) / RefmA (30) / mP (30)
2. Component: FS2 Seminar					
Seminar	1 SWS	1 CP	Consistent participation in the seminar and frequent communication with the supervisor		included in 1st Component

Examination requirements
- none

Calculation of module grade, where applicable
- Grade of the written report or public lecture

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
- MSc Nanosciences

Prerequisites for Participation in this Module
- none

Identifier	Module title
CHE-FB	**Research Course**
	German module title *Forschungsarbeit*

Module SWS (contact hours per week during semester) 7-9 SWS	**Module duration** 1 semester	**Authorised module representative** Lecturers of Chemistry
Credit Points 18 CP	**Module frequency** Each academic year	**Committee responsible for the module** Faculty council of Biology/Chemistry

Learning objectives

The students acquire knowledge of structure formation processes that are coupled with self-organization. They will explore the potential of such structure formation processes for the production of functional materials. By elaborating interactive content modules related to the topic of the module, the students will train how to become acquainted with new scientific areas. They will practice literature research, scientific writing, structuring and summarizing of scientific problems as well as correct referencing.

Content

Nature of self-organized processes and their physical fundamentals; syntheses based on self-organization; structure formation by self-organization; characterization of self-organized structures by microscopy, scattering methods and image analysis; examples of self-organization.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1. Component: FB Seminar on the study project					
Seminar on the study project	6 – 8 SWS	17 CP	Consistent participation in the seminar and frequent communication with the supervisor		RefmA (30) / PP (30) / mP (30)
2. Component: FB Seminar					
Seminar	1 SWS	1 CP	Consistent participation in the seminar and frequent communication with the supervisor		included in 1st component

Examination requirements
- Content and qualification aims of the module

Calculation of module grade, where applicable
- Average of the grades for the written report and the oral or poster presentation.

Guidelines for passing the module, where applicable
- Passing the course-related exams with a grade of at least 4.0.

Guidelines for retaking examinations to improve grades, where applicable
- According to §14 APO

Module Applicability
• MSc Nanosciences
Prerequisites for Participation in this Module
• none

Physics

Module PHY-FS_v1 Professional Specialization	
Identifier	PHY-FS_v1
Module title	Professional Specialization
German module title	Fachliche Spezialisierung
Authorised module representative	Dean of Studies
Qualification objectives	• Independent specialization in a specific topic of physics • Understanding of essential topics • Summarizing results by oral or written presentation • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence
Contents	Guided by a lecturer, the module serves to work independently and deeply on a current research project in experimental and/or theoretical physics. Contents are fixed individually. Examples are: • reading current literature to acquire survey knowledge • reproducing basic elements by studying literature or lab work • evaluating various arguments • writing or presenting the central aspects of the research topic
Module components including CP (LP) information	Professional Specialization (12 LP)
CP of the module	12 LP
SWS (hours per week during the semester) of the module	8 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in winter and summer term
Course credits	Oral exam (30min)
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	-
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-FB: Research Course	
Identifier	PHY-FB
Module title	Research Course
German module title	Forschungsarbeit

Authorised module representative	Dean of Studies
Qualification objectives	• Learning of actual aspects in experimental and theoretical concepts of research in physics • Learning to present scientific results obtained during the course • Self-competence such as self-management, time management, creativity, own initiative, motivation, carefulness, accuracy, endurance, self-confidence, etc.
Contents	The module comprises advanced concepts as well as experimental and theoretical techniques of the physics concerning current fields or research. Contents include: • Comprehending well established results of research • Acquiring own scientific results • Presenting established and self-acquired results using written or oral presentation
Module components including CP (LP) information	Research project (18 LP)
CP of the module	18 LP
SWS (hours per week during the semester) of the module	6-8 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	Closing table (30min)
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences – Materials, Molecules and Cells”
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-AFP-15: Applied Solid State Physics	
Identifier	PHY-AFP-15
Module title	Applied Solid State Physics
German module title	Angewandte Festkörperphysik
Authorised module representative	Dean of Studies

Qualification objectives	• Consolidation of knowledge in experimental solid-state physics, based on exemplary advanced current topics • Acquisition of physics knowledge in English • Examplary application of numerical methods • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence
Contents	This module introduces topics in applied solid-state physics, focussing mainly on electronic transport phenomena and their application in modern electronic devices. Specific contents: • Semiconductor devices (transistors, LEDs, solar cells, microwaves) • Superconductor devices (e.g., SQUID) • Magnetism and spintronics
Module components including CP (LP) information	Lecture with exercises (6 LP)
CP of the module	6 LP
SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually (winter term)
Course credits	Regular attendance of exercises
Required pre-examination achievements	Successful completion of exercises
Type of examination by continuous assessment	Written (120 min) or oral (30 min)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of final exam
Regulations on how to pass the module	Grade ≤ 4.0 ('sufficient' or better)
Retaking to improve grades	Not allowed
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-BMMP-15: Biomacromolecular Physics	
Identifier	PHY-BMMP-15
Module title	Biomacromolecular Physics
German module title	Biomakromolekülphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Introduction into theoretical and experimental fundamentals of biophysics (structure, dynamics and function of biomolecules, thermodynamics of biomolecular processes, etc.) • Acquisition of biophysical knowledge in English • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.

Contents	This module introduces the basics of biophysics. Contents include: • Structure and function of proteins, nucleic acids and membranes • Thermodynamics of biomolecular processes • Protein dynamics • Protein reactions
Module components including CP (LP) information	Lectures with exercises (6 LP)
CP of the module	6 LP
SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in winter or summer term
Course credits	
Required pre-examination achievements	Successful completion of exercise tasks
Type of examination by continuous assessment	Written exam (120 min) or oral exam (30 min)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-OFP-15: Surface Science	
Identifier	PHY-OFP-15
Module title	Surface Science
German module title	Oberflächenphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Introduction to experimental and theoretical concepts of surface science and exemplary applications of the concepts for different materials and experimental techniques • Learning of physics in English • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module comprises basic concepts and experimental techniques of surface science. Contentsinclude: • Basics of experimental and vacuum techniques • Geometric and electronic structure of surfaces • Structural properties and kinetics of adsorbates • Elementary processes on surfaces
Module components including CP (LP) information	Lecture with excercises (6 LP)
CP of the module	6 LP

SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	
Required pre-examination achievements	Successful working on excercises
Type of examination by continuous assessment	Written examination (120 min) or oral examination (30 min)
Examination requirements	All contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-TKM-15: Theory of Condensed Matter	
Identifier	PHY-TKM-15
Module title	Theory of Condensed Matter
German module title	Theorie der Kondensierten Materie
Authorised module representative	Dean of Studies
Qualification objectives	• Introduction to the theoretical concepts of condensed matter physics, application to modern problems • Acquiring physics knowledge from english texts • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The course introduces to basic concepts of condensed matter theory. Contents include: • Basic solid state theory • Elements of theory of electronic structure and many-particle physics • Elements of soft condensed matter theory • Mean field theory
Module components including CP (LP) information	Lecture with exercise classes (6 LP)
CP of the module	6 LP
SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually, either summer or winter-term
Course credits	
Required pre-examination achievements	Successful participation in the excercise classes
Type of examination by continuous assessment	Written (120 min) or oral exam (30 min)

Examination requirements	Mastering of all contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-UKP-15: Ultrafast Physics	
Identifier	PHY-UKP-15
Module title	Ultrafast Physics
German module title	Ultrakurzzeitphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Knowledge about physics of ultrashort laser pulses • Understanding of the properties of ultrashort laser pulses and their interaction with matter, applications • Application of ultrafast physics in spectroscopy with a focus on modern examples of the fields of (nano-) photonics, solid state- and bio-physics. Knowledge about industrial applications, development of ultrafast laser systems, material processing, sensors. • English language skills in the field of ultrafast physics • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module gives an introduction to the fundamentals of ultrafast physics. It includes: • Physics of ultrashort laser pulses • Propagation, correlation and interaction phenomena, i.e. chirp and self-phase modulation • Optical nonlinearities: Two-Photon Absorption, nonlinear index of refraction • Frequency conversion, optical parametric processes • Ultrafast transport phenomena in (nonlinear) optical (nanoscopic) materials: excited carriers, electron-phonon-relaxation, exziton formation, lumineszenz, self-localization of carriers
Module components including CP (LP) information	Lecture with excercises (6 LP)
CP of the module	6 LP
SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Frequency with which the course is offered	Bi-annually in summer or winter term
Course credits	
Required pre-examination achievements	Successful solution of exercise
Type of examination by continuous assessment	Written examination (120 min) or oral examination (30 min)

Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-ACM: Advanced Computer Simulations and Modelling	
Identifier	PHY-ACM
Module title	Advanced Computer Simulations and Modelling
German module title	Fortgeschrittene Computersimulation und Modellierung
Authorised module representative	Dean of Studies
Qualification objectives	• Implementation of advanced computer simulations and modelling • Acquiring physics knowledge from English texts • Self-competence such as self-management, time management, creativity, proactiveness, motivation, carefulness, accurateness, endurance, self-confidence, etc.
Contents	The course introduces to implementation of advanced computer simulations and modelling by means of algorithms, programming, and data analysis. Contents include: • Calculus of condensed matter physics • Elements of programming • Quantum mechanics • Statistical physics • Practical exercises
Module components including CP (LP) information	Lecture with exercise classes (6 LP)
CP of the module	6 LP
SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually, either summer or winter term
Course credits	
Required pre-examination achievements	Successful participation in the exercise classes
Type of examination by continuous assessment	Written exam (120 min) or oral exam (30 min) or oral presentation (30 min)
Examination requirements	Mastering of all contents of the module
Calculation of module grade	
Regulations on how to pass the module	

Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-BPHBI-15: Biophysical and Applied Bioinformatics	
Identifier	PHY-BPHBI-15
Module title	Biophysical and Applied Bioinformatics
German module title	Biophysikalische und Angewandte Aspekte der Bioinformatik
Authorised module representative	Dean of Studies
Qualification objectives	• Knowledge of biophysical properties of proteins, DNA and RNA. • Knowledge of principles and basic algorithms of Computational Biology • Knowledge of databases and servers that contain sequence and structural information together with software for their analyses. • English language skills in the field of Bioinformatics • Self-competence such as self-management, time management, creativity, own initiative, motivation, carefulness, accuracy, endurance, self-confidence, etc.
Contents	This module provides an introduction to the fundamentals of Bioinformatics. It includes: • Physical aspects of Bioinformatics • Proteins as physical systems • RNA and DNA as physical systems • Molecular dynamics simulations • Evolution, Homology, Orthology, Paralogy • Sequence analyses, Alignments (Needleman-Wunsch, BLAST, psi-BLAST), Substitution matrices • Prediction of protein and RNA structures.
Module components including CP (LP) information	Lectures with practicals (6 LP)
CP of the module	6 LP
SWS (hours per week during the semester) of the module	4 SWS
Duration of the module	One semester
Duration of the module	Annually during the winter term
Course credits	
Required pre-examination achievements	Successful participation in the practicals
Type of examination by continuous assessment	Written examination (120 min)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	

Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-BPHBI-M-15: Methods of Applied Bioinformatics	
Identifier	PHY-BPHBI-M-15
Module title	Methods of Applied Bioinformatics
German module title	Methoden der angewandten Bioinformatik
Authorised module representative	Dean of Studies
Qualification objectives	• Experimental and theoretical basics of bioinformatic methods (analysis of operons, genome analysis, functional predictions, structural analysis of substrate-binding sites) • English language skills in the field of bioinformatic methods • Self-competence such as self-management, time management, creativity, own initiative, motivation, carefulness, accuracy, endurance, self-confidence, etc.
Contents	This module gives an introduction to the fundamentals of bioinfomatic methods. It includes: • Databases and servers (e.g. EBI, NCBI, DDBJ), • Multiple alignments (e.g. Clustal, T-Coffee, MUSCLE) und phylogenetic analysis • Comparison of protein folds and their classification (e.g. SCOP, CATH) • Methods of structure prediction • Methods of molecular dynamics simulations
Module components including CP (LP) information	Lectures and homework (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Duration of the module	Annually during the summer term
Course credits	
Required pre-examination achievements	Successful completion of the homework
Type of examination by continuous assessment	Written examination (120 min) and Homework
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of Module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-BPHBI-P-15: Practical Course in Applied Bioinformatics and Evolutionary Biophysics	
Identifier	PHY-BPHBI-P-15
Module title	Practical Course in Applied Bioinformatics and Evolutionary Biophysics
German module title	Praktikum zur Angewandten Bioinformatik und Evolutionären Biophysik
Authorised module representative	Dean of Studies
Qualification objectives	• Acquisition of in-depth knowledge and experimental skills in a specific area of computational biology or evolutionary biophysics • Self-management such as time management, creativity, own initiative, motivation, carefulness, accurateness, endurance, self-confidence, etc.
Contents	Independent training in special topics of computational biology or evolutionary biophysics and practical implementation of the skills obtained in experimental work. Contents include: • Introduction into a special topic of computational biology or evolutionary biophysics • Practical implementation of the experimental concepts • Conducting computer-based analysis in the field of computational biology or evolutionary biophysics • Writing an internship report
Module components including CP (LP) information	Practical (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Duration of the module	Annually during the summer semester
Course credits	Successful participation in the practical, evaluation and processing of special experimental problems; written internship report or oral presentation
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-BPHBI-S-15: Seminar in Applied Bioinformatics and Evolutionary Biophysics	
Identifier	PHY-BPHBI-S-15
Module title	Seminar in Applied Bioinformatics and Evolutionary Biophysics
German module title	Seminar zur Angewandten Bioinformatik und Evolutionäre Biophysik
Authorised module representative	Dean of Studies
Qualification objectives	• Independent preparation and delivery of talks in the fields of Bioinformatics, Computational Biology and Evolutionary Biophysics • English language skills in the field of Bioinformatic methods • Self-competencies such as self-management, time management, creativity, own initiative, motivation, carefulness, accurateness, endurance, self-confidence, etc.
Contents	The course deals with selected questions of evolution of Biophysical processes. Contents include: • Evolution of enzyme mechanisms, • Biophysics of protein evolution, • Biophysics of RNA- and DNA-evolution, • Evolution of prokaryotes • Basics of comparative genomics • Structure prediction
Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Duration of the module	Annually during the summer term
Course credits	
Required pre-examination achievements	A successful delivery of a talk and compulsory regular attendance of all seminars, participation in the discussions
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-BMMP-M-15: Techniques of Biomacromolecular Physics	
Identifier	PHY-BMMP-M-15
Module title	Techniques of Biomacromolecular Physics
German module title	Methoden der Biomakromolekülphysik

Authorised module representative	Dean of Studies
Qualification objectives	• Experimental and theoretical fundamentals of Biophysical methods (spectroscopy, modeling, etc.) • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The course introduces the methods of Biophysics. Contents include: • Spectroscopy: Mössbauer spectroscopy, X-ray spectroscopy, UV-Vis-, IR-, Raman- spectroscopy, NMR, ESR spectroscopy • Modeling, molecular dynamics simulations
Module components including CP (LP) information	Lecture with exercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in winter or summer term
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Written exam (60 min) or oral exam (20 min) and a homework
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-BMMP-P-15: Practical Course: Biomacromolecular Physics	
Identifier	PHY-BMMP-P-15
Module title	Practical Course: Biomacromolecular Physics
German module title	Praktikum zur Biomakromolekülphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Acquisition of in-depth knowledge and experimental skills in a specific area of biophysics. • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	Independent training in special topics of Biophysics and practical implementation of the skills obtained in experimental work. Contents include: • Introduction into a special topic in Biophysics • Practical implementation of the experimental concepts • Conducting experiments in the field of Biophysics • Writing an internship report

Module components including CP (LP) information	Practical (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually during the winter or summer term
Course credits	Successful participation in the practical, evaluation and processing of special experimental problems; written internship report or oral presentation
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-BMMP-S-15: Seminar: Biomacromolecular Physics	
Identifier	PHY-BMMP-S-15
Module title	Seminar: Biomacromolecular Physics
German module title	Seminar zur Biomakromolekülphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Independent preparation and delivery of talks in the field of Biophysics • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The course deals with selected questions of Biophysics. Contents include: • Structure, dynamics and function of proteins, nucleic acids and membranes • Thermodynamics of biomolecular processes • Spectroscopy in Biophysics • Molecular dynamics simulations
Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually during the winter or summer term

Course credits	A successful delivery of a lecture and compulsory regular attendance of all seminars, participation in the discussions
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-NQP-15: Computational Quantum Physics	
Identifier	PHY-NQP-15
Module title	Computational Quantum Physics
German module title	Numerische Quantenphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Deepened knowledge of quantum mechanics • Implementation of advanced numerical methods • Self-competence such as self-management, time management, creativity, proactiveness, motivation, carefulness, accurateness, endurance, self-confidence, etc.
Contents	The module applies advanced numerical methods to problems in the context of quantum mechanics. Topics include: • Quantum dynamics • Lattice models of interacting spin, fermions, and bosons • Use of Symmetries • Extension of programming skills • Application to specific problems • Writing of a scientific report
Module components including CP (LP) information	Practical (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually, either summer or winter term
Course credits	Successful participation in the practicum, written report or oral presentation
Required pre-examination achievements	

Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-OFP-P-15: Laboratory Course: Physics of Thin Films	
Identifier	PHY-OFP-P-15
Module title	Laboratory Course: Physics of Thin Films
German module title	Praktikum zur Oberflächenphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Learning of advanced knowledge and experimental abilities of special fields of surface science • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The student has to deepen his/her knowledge on a special subject in the field of surface science and apply this to practical exercises. Contents inclusde: • Settling into a special subject of surface science • Practical application of theoretical concepts • Final report
Module components including CP (LP) information	Laboratory course (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	Successful participation in laboratory course, analysis of distinct experiments, written report or oral presentations
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	

Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-OFP-S-15: Seminar: Surface Science	
Identifier	PHY-OFP-S-15
Module title	Seminar: Surface Science
German module title	Seminar zur Oberflächenphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Gathering knowledge on a special subject of surface science and presenting this to an auditorium • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The student has to deepen his/her knowledge on a special subject in the field of surface science and to present his/her knowledge to an auditorium. Contents include: • Physical concept of distinct phenomena in surface science • Physical concept of experimental techniques in surface science
Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	Successful presentation of an oral presentation and regular participation at the seminar. The student has the duty to participate regularly at the seminar.
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-PCMS-15: Practicum Computational Materials Science	
Identifier	PHY-PCMS-15
Module title	Practicum Computational Materials Science
German module title	Praktikum Computersimulationen in den Materialwissenschaften
Authorised module representative	Dean of Studies
Qualification objectives	• Knowledge of various basic computer simulation methods, their merits and limits, and their mutual relations • Practical implementation of simulation algorithms • Competence for development of models and respective computer simulation techniques to describe structural and dynamical properties of complex materials • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	Techniques are conveyed to conduct computer simulations for exploring structural and dynamical properties of materials. Contents include: • Basic methods of computer simulations in condensed matter physics • Applications to structural properties of fluids, soft matter systems as well as crystalline and amorphous solids • Applications to transport and relaxation processes in soft matter systems and solids
Module components including CP (LP) information	Practical (3LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either the summer or winter term
Course credits	Written report or oral presentation of methods and results
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-PCN-15: Physics of Carbon Nanostructures (lecture)	
Identifier	PHY-PCN-15
Module title	Physics of Carbon Nanostructures (lecture)
German module title	Physik der Kohlenstoff-Nanostrukturen
Authorised module representative	Dean of Studies
Qualification objectives	• Specific knowledge in the physics of carbon nanostructures • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	Introduction to basic concepts and application-relevant methods in the area of 'physics of carbon nanostructures' Exemplary contents: • Carbon nanostructures – classification and general properties • Fullerenes: chem. modification, quantum and solar applications • Nanotubes and graphene: electronic transport and sensing • Diamond: defects, electronics, sensing and quantum application
Module components including CP (LP) information	Lecture (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually
Course credits	Regular attendance
Required pre-examination achievements	Open to regular participants
Type of examination by continuous assessment	Written (60 min) or oral (20 min)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of final examination
Regulations on how to pass the module	Grade ≤ 4.0 ('sufficient' or better)
Retaking to improve grades	Not allowed
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-PCN-P-15: Physics of Carbon Nanostructures (lab course)	
Identifier	PHY-PCN-P-15
Module title	Physics of Carbon Nanostructures (lab course)
German module title	Praktikum zur Physik der Kohlenstoff-Nanostrukturen
Authorised module representative	Dean of Studies
Qualification objectives	• Gain hands-on experience in experimental physics • Learn about good laboratory practices, hone team work skills • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.

Contents	Project-based work in the physics of carbon nanostructures. Exemplary topics / areas: • CVD synthesis of carbon materials (nanotubes, diamond) • Physical modification by ion implantation • Chemical modification (simple one-pot reactions) • Preparative work (purification, surface treatments) • Microelectronics methods (metallisation, lithography) • Analysis and characterization (structural, optical, electronic, spin)
Module components including CP (LP) information	Lab course (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Each semester
Course credits	Participation in lab course + treatment of specific experimental problem + written lab protocol + short oral presentation
Required pre-examination achievements	Lab protocol deemed sufficient
Type of examination by continuous assessment	Oral presentation (20 min)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of presentation (25%) and grade of lab protocol (75%)
Regulations on how to pass the module	Grade ≤ 4.0 ('sufficient' or better)
Retaking to improve grades	Not allowed
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-PCN-S-15: Physics of Carbon Nanostructures (seminar)	
Identifier	PHY-PCN-S-15
Module title	Physics of Carbon Nanostructures (seminar)
German module title	Seminar zur Physik der Kohlenstoff-Nanostrukturen
Authorised module representative	Dean of Studies
Qualification objectives	• (Self-) Acquisition of experimental und theoretical concepts in the physics of carbon nanostructures • Develop communication and presentation skills • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	Detailed discussions of basic topics in the area of applied methods, esp. in the context of carbon nanostrucure physics Exemplary topics: • Electronic transport in 1D und 2D materials • Electronic bio-sensing with carbon nanotube transistors • Methods and concepts of electron spin resonance • Optical bio-sensing with nano-diamonds • Spin-based quantum sensing and quantum computing

Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually, alternating with lecture PHY-PCN-15
Course credits	Participation in seminar and own presentation
Required pre-examination achievements	Independent preparation of a technical topic
Type of examination by continuous assessment	Seminar presentation with discussion
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of presentation
Regulations on how to pass the module	Grade ≤ 4.0 ('sufficient' or better)
Retaking to improve grades	Not allowed
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-PFM-15: Physics of Functional Materials	
Identifier	PHY-PFM-15
Module title	Physics of Functional Materials
German module title	Physik funktionaler Materialien
Authorised module representative	Dean of Studies
Qualification objectives	• Learning of experimental and theoretical concepts of the physics of functional materials • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module comprises basic concepts and experimental techniques of the physics of functional materials. Contents include: • Modification of physical properties due to lower dimension • Impact of defects and material properties • Application in the fields of electronic and magnetic materials
Module components including CP (LP) information	Lecture with excercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	

Required pre-examination achievements	
Type of examination by continuous assessment	Written examination (60 min) or oral examination (20 min)
Examination requirements	All contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-PSY-15: Physics with Synchrotron Radiation	
Identifier	PHY-PSY-15
Module title	Physics with Synchrotron Radiation
German module title	Physik mit Synchrotronstrahlung
Authorised module representative	Dean of Studies
Qualification objectives	• Learning of experimental and theoretical concepts of the physics using synchrotron radiation • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module comprises basic concepts and experimental techniques of the physics using synchrotron radiation. Contents include: • Interaction of x-rays with matter • Sources of synchrotron radiation – generation and instruments • Techniques and applications of spectroscopy • Diffraction techniques and their application • Imaging techniques (x-ray microscopy)
Module components including CP (LP) information	Lecture with excercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	
Required pre-examination achievements	Written examination (60 min) or oral examination (20 min)
Type of examination by continuous assessment	All contents of the module
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	

Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-PUDS-15: Physics of Ultrathin Films	
Identifier	PHY-PUDS-15
Module title	Physics of Ultrathin Films
German module title	Physik Ultradünner Schichten
Authorised module representative	Dean of Studies
Qualification objectives	• Learning of experimental and theoretical concepts of the physics of thin and ultrathin films • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module comprises basic concepts and applied techniques of the physics of ultrathin films. Contents include: • Deposition techniques • Experimental techniques to characterize ultrathin films • Morphology and defects • Elektronic, optical and magnetic properties of ultrathin films • Transport in ultrathin films
Module components including CP (LP) information	Lecture with excercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One emester
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	
Required pre-examination achievements	Written examination (60 min) or oral examination (20 min)
Type of examination by continuous assessment	All contents of the module
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-SDS-15: Stochastical Dynamical Systems	
Identifier	PHY-SDS-15
Module title	Stochastical Dynamical Systems
German module title	Stochastische dynamische Systeme
Authorised module representative	Dean of Studies
Qualification objectives	• Consolidation of condensed matter theory • Knowledge of stochastic methods for the description and modelling of systems whose dynamics is influenced by random forces • Application of stochastic methods with focus on current research in Materials science, Biophysics and further interdisciplinary research areas (e.g., physiology, finance) • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	Concepts and methods are conveyed to describe stochastic dynamical systems, which occur in many areas of physics as well as many other scientific fields. Contents include: • Basis principles of probability theory, central limit theorem and generalisations, extreme value statistics • Theory of stochastic processes; Markov processes; Gauß, Poisson and shot noise processes • Correlation functions, cumulants, stationary processes, spectral decomposition, Wiener-Khinchin theorem • Linear response theory and fluctuation-dissipation theorem • Langevin- and Fokker-Planck equations; master equation • Stochastic thermodynamics; detailed and integral fluctuation theorems
Module components including CP (LP) information	Lecture with exercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in either the summer or winter term
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Written exam (60 min.) or oral exam (20 min.)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-TRQ-15: Transport and Relaxation Dynamics in Quantum Systems	
Identifier	PHY-TRQ-15
Module title	Transport and Relaxation Dynamics in Quantum Systems
German module title	Transport und Relaxationsdynamik in Quantensystemen
Authorised module representative	Dean of Studies
Qualification objectives	• Consolidation of condensed matter theory • Application of the theory to non-equilibrium processes in condensed matter systems • Profound understanding of non-equilibrium pysics in quantum systems • Acquiring physics knowledge from english texts • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The course introduces the non-equilibrium physics of quantum systems. Contents include: • Mapping of quantum dynamics onto master equations • Relaxation of excited states • Introduction to transport theory • Green-Kubo-formalsim • Calculating relaxation times ans transport coefficients
Module components including CP (LP) information	Lecture with excercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually, either summer or winter term
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Written examination (60 min) or oral examination (20 min)
Examination requirements	All contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-UKP-E-15: Introduction: Ultrafast Physics	
Identifier	PHY-UKP-E-15
Module title	Introduction: Ultrafast Physics
German module title	Einführung in die Ultrakurzzeitphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Knowledge about physics and mathematical description of ultrashort laser pulses • Understanding of the properties of ultrashort laser pulses and their interaction with matter, applications • Understanding of the propagation of ultrashort laser pulses • Nonlinear optical phenomena and phase matching conditions • Ultrashort pulse laser systems • English language skills in the field of ultrafast physics • Self-competence such as self-management, time management, creativity, own initiative, motivation, carefulness, accuracy, endurance, self-confidence, etc.
Contents	The module gives an introduction to the fundamentals of ultrafast physics. Itincludes: • Physics of ultrashort laser pulses • Propagation, correlation and interaction phenomena, i.e. chirp and self-phase modulation • Optical nonlinearities: Two-Photon Absorption, nonlinear index of refraction • Frequency conversion, optical parametric processes • Laser system resonators, Kerr lens design, Pockels cells
Module components including CP (LP) information	Lecture (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Bi-annually in summer or winter term
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Written examination (60 min) or oral examination (20 min)
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	

Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-UKP-F: Advanced Ultrafast Physics	
Identifier	PHY-UKP-F
Module title	Advanced Ultrafast Physics
German module title	Fortgeschrittene Ultrakurzzeitphysik
Authorised module representative	Dean of Studies
Qualification objectives	• In-depth presentation of selected topics from ultrafast physics Self-competencies such as self and time management, personal initiative, motivation, diligence, willingness to perform, accuracy, endurance, self-confidence, etc.
Contents	The lecture provides in-depth knowledge on a topic of ultrafast physics on a high level. Typically, it involves: • The physical background of current research results • The discussion of research results in an interdisciplinary context or • The physical background of new fields of research.
Module components including CP (LP) information	Lecture with exercises (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Annually in summer or winter term
Course credits	
Required pre-examination achievements	Successful solution of exercise
Type of examination by continuous assessment	Written examination (60 min) or oral examination (20 min)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik

Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-UKP-P-15: Laboratory Course: Ultrafast Physics	
Identifier	PHY-UKP-P-15
Module title	Laboratory Course: Ultrafast Physics
German module title	Praktikum zur Ultrakurzzeitphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Experience with experimental techniques in the laboratory for ultrafast physics and with ultrashort laser pulses • Application to modern research topics • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module shows and imparts skills in the context of ultrafast physics. Contents include: • Generation of ultrashort laser pulses • Detection of ultrashort laser pulses via detectors and autocorrelation techniques • Temporal control of ultrashort laser pulses • Nonlinear optical fs-spectroscopy, holographic ultrafast spectroscopy, UV/VIS/MIR fs-spectroscopie • Application to modern research topics in the field of (nano-) photonics, solid state – and bio-physics.
Module components including CP (LP) information	Practical (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Bi-anually in either summer or winter term
Course credits	Successful participation, analysis and study of specific experimental questions, written report or oral presentation
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-UKP-S-15: Seminar: Ultrafast Physics	
Identifier	PHY-UKP-S-15
Module title	Seminar: Ultrafast Physics
German module title	Seminar zur Ultrakurzzeitphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Competence in techniques and giving of professional talks and presentation • Application to modern research topics in the field of ultrafast physics • Self-competencies such as self and time management, initiative, willingness to perform, motivation, diligence, accuracy, persistence, self-confidence, etc.
Contents	The module introduces the techniques and the giving of talks and presentations with modern research topics in the field of ultrafast physics as an example. Content includes: • Selection and finding of topics, outline and search • Time management and planning of the preparation phase • Techniques of presentation (i.e. with power point or prezi) • Creative elements of presentations, implementation of media • Speech techniques, rhethoric, voice control • Selfreflection and critical discussion with seminar participants • Detailed study of modern research topics in the field of ultrafast physics
Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	Bi-anually in either summer or winter term
Course credits	Successful presentation of a talk and regular participation at the seminar. Presence at talk and discussion
Required pre-examination achievements	
Type of examination by continuous assessment	
Examination requirements	
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-EV-V-y: Complement and Deepen the Knowledge of Physics: y	
Identifier	PHY-EV-V-y
Module title	Complement and Deepen the Knowledge of Physics: y
German module title	Ergänzung und Vertiefung zur Physik: y
Authorised module representative	Dean of Studies
Qualification objectives	• Acquisition of supplementary or in-depth knowledge of physics • Social skills such as the ability to cooperate, advisory skills as well as personal skills such as time and self-management, initiative, diligence, accuracy, perseverance, etc.
Contents	Selected topics in physics Different module contents are distinguished by different sub-identifiers y∈{A,B,C,...,Z}.
Module components including CP (LP) information	Lecture (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	As required in summer or winter semester
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Written exam (90 min) or oral exam (30 min)
Examination requirements	Mastering of all contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module Prerequisites for participation in this module	MSc “Nanosciences - Materials, Molecules and Cells“ Possible prerequisites see under respective “examination regulations”

Modul PHY-EV-S-y: Complement and Deepen the Knowledge of Physics: y	
Identifier	PHY-EV-S-y
Module title	Complement and Deepen the Knowledge of Physics: y
German module title	Ergänzung und Vertiefung zur Physik: y
Authorised module representative	Dean of Studies
Qualification objectives	• Acquisition of supplementary or in-depth knowledge of physics • Social skills such as the ability to cooperate, advisory skills as well as personal skills such as time and self-management, initiative, diligence, accuracy, perseverance, etc.
Contents	Selected topics in physics Different module contents are distinguished by different sub-identifiers $y \in \{A,B,C,...,Z\}$.
Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	One semester
Frequency with which the course is offered	As required in summer or winter semester
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Oral exam (30 min) or oral presentation and written report
Examination requirements	Mastering of all contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module Prerequisites for participation in this module	MSc “Nanosciences - Materials, Molecules and Cells“ Possible prerequisites see under respective “examination regulations”

Modul PHY-MPP: Many Particle Physics	
Identifier	PHY-MPP
Module title	Many Particle Physics
German module title	Vielteilchenphysik
Authorised module representative	Dean of Studies
Qualification objectives	• Deepened knowledge on selected topics in the context of many particle physics • Acquiring physics knowledge from English texts • Self-competence such as self-management, time management, creativity, proactiveness, motivation, carefulness, accurateness, endurance, self-confidence, etc.
Contents	The course deepens knowledge on selected topics in the context of many particle physics. Contents are oriented according to topics of theoretical condensed matter physics.
Module components including CP (LP) information	Seminar (3 LP)
CP of the module	3 LP
SWS (hours per week during the semester) of the module	2 SWS
Duration of the module	one semester
Frequency with which the course is offered	Each semester
Course credits	
Required pre-examination achievements	
Type of examination by continuous assessment	Oral exam (30 min) or oral presentation (30 min) or written report
Examination requirements	Mastering of all contents of the module
Calculation of module grade	
Regulations on how to pass the module	
Retaking to improve grades	
Decision-making body for the module	Fachbereichsrat Physik
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”