UNIVERSITÄT OSNABRÜCK

FACHBEREICH MATHEMATIK/INFORMATIK/PHYSIK UND FACHBEREICH BIOLOGIE/CHEMIE

MODULBESCHREIBUNGEN

FÜR DEN MASTERSTUDIENGANG

„NANOSCIENCES –

MATERIALS, MOLECULES AND CELLS“

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

Änderung
beschlossen in der
6. Sitzung des Fachbereichsrats des Fachbereichs Mathematik/Informatik/Physik am 15.05.2024
und in der 151. Sitzung des Fachbereichsrats des Fachbereichs Biologie/Chemie 29.05.2024
befürwortet in der 183. Sitzung der Ständigen zentralen Kommission für Studium und Lehre und Studienqualitätskommission (ZSK) am 10.07.2024
genehmigt in der 405. Sitzung des Präsidiums am 15.08.2024
AMBl. der Universität Osnabrück Nr. 07/2024 vom 24.09.2024, S. 1201

Preface

Besides the continuous assessment examination methods described in § 10 of the "General Examination Regulations for Bachelor's and Master's Programs (APO) of the University of Osnabrück", the following further continuous assessment examination methods will be used:

1) Seminar talk (time in minutes)
The student demonstrates that he/she is able to present, introduce, visualize and summarize a scientific problem for a scientific audience abiding by scientific standards. For this purpose, the student gives an oral talk supported by appropriate technical means. In the subsequent scientific discussion on the topic of the talk the student evidences that he/she is able to participate in a scientific discussion on the topic of the talk. The student 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 selected topic. The seminar talk can take place in public at the university according to the examiner's decision. The form and duration of the talk presentation will be in accordance with the requirements of the module description.

2) Poster presentation (time in minutes)
The student demonstrates that he/she is able to present, introduce, visualize and summarize a scientific problem for a scientific audience abiding by scientific standards. For this purpose, the student prepares a poster on the selected scientific problem. The student evidences that he/she can participate in a scientific discussion on the topic of the poster in a poster session. The student 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 topic of the poster. The poster session can take place in public at the university according to the examiner's decision. The form and duration of the poster session will be in accordance with the requirements of the module description.

3) Written report/protocol
The student demonstrates that he/she is able to present, to document, to visualize and to summarize the results of a literature research on the scientific state-of-the-art of a selected topic and/or the results of tasks in a practical course and/or the results of a research project in the written form abiding by scientific standards. The student moreover demonstrates that he/she is familiar with the scientific principles, and the scientific contexts of the selected topic and that he/she is familiar with the basics of scientific writing including appropriate incorporation of scientific literature.

Duration and scope of examinations
Unless otherwise stated in the individual biology module descriptions, protocols are generally 10-30 pages long (approx. 12,000-36,000 characters), presentations are generally 15-30 minutes long, examinations are generally 60-90 minutes long and oral examinations are generally 30-60 minutes long.

Compulsory attendance

For reasons of health and safety, attendance is compulsory at the seminars on the practical courses. Participation in a 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	Language
BIO-NFM-BAC1	**Focus Module Bioanalytical Chemistry 1 – Proteomics in Cell Biology** *German module title:* *Fokusmodul Bioanalytische Chemie 1 – Proteomics in der Zellbiologie*	German or English by arrangement

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Bioanalytical Chemistry
Credit points	**Availability**	**Committee responsible for the module**
5 CP	Winter or summer semester	School of biology/chemistry – executive board

Qualification objectives

Basic knowledge of the principles of mass spectrometry-based proteomics in cell biology for analysing the structure, function and dynamics of proteins within cellular systems

Contents

SEMINAR: Fundamentals of modern methods of proteome analysis in the context of cell biology issues will be taught. The focus is on various mass spectrometric systems such as MALDI-TOF, ESI-LC-MS and similar technologies. In addition, various areas of application are explained, including the identification of protein-protein interactions, the analysis of post-translational modifications, the determination of the total proteome of cells as well as the measurement of protein turnover or the determination of the proteomes of purified organelles. Furthermore, the theoretical background of mass spectrometric analysis of proteomes ("data dependent analysis" (DDA) and "data independent analysis" (DIA)) is explained.

EXERCISES: Experiments are used to teach students the basics of proteomics. The setup of a mass spectrometer is demonstrated using an example. Experiments will also be used to introduce students to the operation of mass spectrometers and the analysis of proteomics data sets.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NFM-BC2	**Focus Module Biochemistry 2 – Biochemical Purification Methods** *German module title:* *Fokusmodul Biochemie 2 – Biochemische Reinigungsmethoden*	German or English by arrangement

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Biochemistry
Credit points 5 CP	**Availability** Winter or summer semester	**Committee responsible for the module** School of biology/chemistry – executive board

Qualification objectives

Providing advanced knowledge of the properties of proteins and their activity, presentation of methods for the purification of proteins (precipitation methods, ion exchange chromatography, gel filtration, affinity purification) and their analysis such as gel electrophoresis, enzymatic assays, colourimetric detection.

Contents

SEMINAR: Function of proteins and their amino acid side chains, protein structure and function, methods of protein purification, affinity purification, protein analysis such as enzyme tests and gel electrophoresis.

EXERCISES: Application of protein purification methods and determination of their efficiency. Enzymatic analysis, western blotting, gel electrophoresis, protein analysis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NFM-BP1	**Focus Module Biophysics 1 – Biomolecular Interactions** *German module title:* *Fokusmodul Biophysik 1 – Biomolekulare Interaktionen*	German or English by arrangement

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Biophysics
Credit points 5 CP	**Availability** Winter or summer semester	**Committee responsible for the module** School of biology/chemistry – executive board

Qualification objectives

Students will acquire advanced scientific competences in molecular biophysics. They will expand their knowledge of the physicochemical and mechanistic principles of biomolecular interactions. They will be introduced to methodologies for identification, validation and quantitative characterisation of biomolecular interactions and gain hands-on experience with selected techniques.

Contents

SEMINAR: Basic principles of non-covalent interactions and molecular recognition; equilibrium and kinetics of biomolecular interactions; methods for the identification of interaction partners; methods of interaction analysis in vitro and in cells; quantitative analysis of biomolecular interactions.
EXERCISES: Quantitative protein interaction analysis using various measurement techniques.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module: Basic knowledge in molecular biophysics.

Identifier	Module title	Language
BIO-NFM-EMB	**Focus Module Experimental Membrane Biology** *German module title:* *Fokusmodul Experimentelle Membranbiologie*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Bioanalytical Chemistry and Molecular Cell Biology
Credit points	**Availability**	**Committee responsible for the module**
5 CP	Summer semester	School of biology/chemistry – executive board

Qualification objectives

Basic knowledge of the structure, function and dynamics of cell membranes as well as the experimental approaches used to analyse their composition and functional properties.

Contents

SEMINAR: The lecture provides basic knowledge about the role of membranes in cells and organisms. The molecular organisation and physical properties of cell membranes are discussed, as well as the biological diversity of membrane proteins and lipids. Furthermore, membrane biogenesis and membrane homeostasis will be discussed and how deviations in the lipid composition of membranes can contribute to neurodegenerative diseases, diabetes and cancer. In addition, students are familiarised with experimental approaches to determine the molecular composition and physical properties of membranes (membrane proteomics and lipidomics). The use of model membrane systems and innovative methods for the determination of lipid function and the visualisation of lipid transport will also be discussed.

EXERCISES: Experiments are used to teach students the basics of mass spectrometry for analysing the molecular composition of cell membranes. Through a "paper practical", students learn to develop step-by-step experimental strategies for solving membrane-related scientific questions. Using interactive blackboard presentations with scientific staff, students are introduced to ongoing membrane research in the relevant departments.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.
Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NFM-IB	**Focus Module Immunobiology – Immunobiology** *German module title:* *Fokusmodul Immunbiologie – Immunbiologie*	German or English by arrangement

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Animal Physiology, Biophysics, Microbiology
Credit points	**Availability**	**Committee responsible for the module**
5 CP	Winter or summer semester	School of biology/chemistry – executive board

Qualification objectives

Students should acquire advanced scientific competences. They will expand their knowledge of the biology of the mammalian immune system. The principles of recognising 'self' and 'other' by the immune system are taught. Students learn how the immune system can recognise and inactivate infectious agents and tumour cells and understand how malfunctions of the immune system can lead to diseases. Through exercises, they become familiar with important methods of molecular and cellular immunobiology and can apply these to immunological issues.

Contents

SEMINAR: Molecules, cells and organs of the immune system; molecular and cellular concepts of innate and adaptive immune responses; infection immunology; diseases of the immune system.
EXERCISES: Methods of molecular and cellular immunology: handling of immune cells in culture; quantitative microscopy & flow cytometry; infection of cells with bacteria and viruses and defence by antimicrobial functions of immune cells.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NFM-US1	**Focus Module Ultrastructure 1 – Ultrastructural Analytics** *German module title:* *Fokusmodul Ultrastruktur 1 – Ultrastrukturanalytik*	German or English by arrangement

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Microbiology and iBiOs
Credit points	**Availability**	**Committee responsible for the module**
5 CP	Winter or summer semester	School of biology/chemistry – executive board

Qualification objectives

In this method-orientated module, students learn the basics of ultrastructural analysis of cells using electron microscopy (EM). The basics of scanning and transmission electron microscopy (SEM, TEM) are introduced and steps of sample preparation, microscopy and data analysis are taught. The possibilities and limitations, as well as correct and incorrect interpretation of EM analyses are discussed. Basic practical work experience with sample preparation of prokaryotic and eukaryotic cells, their analysis using SEM and TEM, and image evaluation will be acquired.

Contents

SEMINAR: Basics of electron optics, construction of SEM and TEM systems. Sample preparation techniques, fixation, cryo-preparation, contrasting, ultra-thin sections. Immuno-labelling in EM, further labelling techniques for EM. Critical consideration of artefacts and misinterpretations in ultrastructural analysis, and requirements for evaluations of EM data. Introduction to correlative light and electron microscopy. Basics of volumetric EM (FIB-SEM, SFB-SEM, array-SEM, tomography) are introduced and presented using the example of research projects of the lecturers.

EXERCISES: Own and prepared sample material is guided through the various steps of fixation, contrasting, embedding and production of ultra-thin sections. Images of the sample material are taken with SEM and TEM and analysed using standard software (open source). The results will be presented and discussed in a joint symposium.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.
Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NFM-NB1	**Focus Module Neurobiology 1 – Biology of Neurodegenerative Diseases and Mental Disorders** *German module title:* *Fokusmodul Neurobiologie 1 – Biologie neurodegenativer Erkrankungen und psychischer Störungen*	German or English by arrangement

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Neurobiology
Credit points 5 CP	**Availability** Winter or summer semester	**Committee responsible for the module** School of biology/chemistry – executive board

Qualification objectives

Students should acquire advanced scientific competences. They acquire in-depth knowledge of selected neurobiological processes using the example of typical neurodegenerative diseases and mental disorders and develop an understanding of the neurobiological processes and relationships in a physiological and pathological context. You will be able to transfer this knowledge to new situations and derive conclusions. Through intensive study of the primary literature, the current state of research, methodological approaches and approaches to therapy are developed.

Contents

SEMINAR: Neurobiological background and state of research in exemplary neurodegenerative diseases and mental disorders (e.g. Parkinson's, Alzheimer's, amyotrophic lateral sclerosis, multiple sclerosis, autism and retinitis pigmentosa).

EXERCISES: Using primary literature, in-depth specialist and methodological knowledge of neurodegenerative diseases and mental disorders and the current state of research as well as approaches to possible therapies are developed.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Successful answering of questions on selected primary literature in the VIPS module or in the form of approved papers.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NFM-TP1	**Focus Module Animal Physiology 1 – Human Stem Cells** *German module title:* *Fokusmodul Tierphysiologie 1 – Humane Stammzellen*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
4 SWS	One semester, block course	Lecturers in Animal Physiology
Credit points	**Availability**	**Committee responsible for the module**
5 CP	Winter or summer semester	School of biology/chemistry – executive board

Qualification objectives

Teaching basic knowledge of human stem cells and their applications.

Contents

SEMINAR: Occurrence, properties and role of human stem cells; production of pluripotent stem cells (iPSC technology); differentiation of human tissues from iPSCs and adult stem cells; organoids.
EXERCISES: Cell culture experiments on the subject of stem cells, e.g. cell culture techniques and materials for stem cell cultivation, examination using antibody staining; differentiation of stem cells into tissue cells.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	2	Compulsory attendance, as a prerequisite for the practical exercises		Written exam or MC exam on the contents of the module or protocol or presentation or oral examination as specified by the lecturer at the beginning of the course.
2nd Component:					
Excercises	3	3	Approved protocols. Regular participation in the exercises is required, as study and work-related content and skills must be acquired and practised.		

Examination requirements: Competences relating to the contents of the lecture are tested.

Calculation of the module grade: Grade of the course-related examination.

Guidelines for passing the module: 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"; interdisciplinary compulsory elective area for focus "Chemistry" or "Physics". Participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module: Basic knowledge in molecular cell biology.

Identifier	Module title	Language
BIO-NMM-BC1_v1	**Master Module Biochemistry: Structural and Pathobiochemistry** *German module title:* *Mastermodul: Pathobiochemie*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-BC2_v1	**Master Module Biochemistry: Molecular Cell Biochemistry: Intracellular Protein Sorting and Function** *German module title:* *Mastermodul Biochemie: Molekulare Zellbiologie/Biochemie*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Biochemistry
Credit Points 12 CP	**Module frequency** Lecture and Seminar in each winter term, Exercises in each summer term	**Committee responsible for the module** School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-BO1	**Master Module Botany: Molecular Plant Developmental Genetics** *German module title:* *Mastermodul Botanik: Molekulare Entwicklungsgenetik der Pflanzen*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Botany
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	School of biology/chemistry – executive board

Learning objectives

Students should develop advanced, in-depth scientific skills in the molecular control of complex development and differentiation processes. They should be able to independently interpret phenotypes and molecular data and classify them in regulatory control cascades in order to build on the knowledge they have acquired in order to provide their own transfer services. Current biochemical, molecular biological, cell biological and bioinformatic working methods for isolating and analyzing genes and their functions are taught in the lecture and practical course. The experimentally collected data is analyzed, graphically presented and critically discussed. Lectures and seminars in English train students to understand and give presentations in English and to read English specialist texts

Content

LECTURE: Starting from undifferentiated, totipotent stem cells, various plant organs with different functions are constructed by differential gene expression. This requires complex molecular control processes that are controlled by key regulatory transcription factors. Different levels of expression regulation are presented (transcriptional, translational control, miRNAs, epigenetic phenomena, influence of hormones, signal transduction cascades). Using genetic model plants, knowledge about the molecular control of organogenesis and diversity formation will be imparted.

SEMINAR: With the help of primary literature, in-depth technical and methodological-theoretical knowledge from the field of plant developmental genetics is imparted.

EXERCISES: Molecular-genetic methods for the investigation of developmental genetic mutants: cell biological, genetic and biochemical techniques; expression studies on mRNA (in situ hybridization, RT-PCR, promoter reporter) and protein level (GFP fusions, BiFC), protein/DNA EMSA interaction analyses, gene isolation and sequencing with bioinformatic data processing, analysis of homeotic mutants with altered organogeneses to apply the theoretically acquired knowledge.

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-BP1	**Master Module Biophysics: Biological Spectroscopy and Microscopy** *German module title:* *Mastermodul Biophysik: Biologische Spektroskopie und Mikroskopie*	English

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	School of biology/chemistry – executive board

Learning objectives

In the lecture, students expand and deepen their scientific and methodological skills in the field of spectroscopy and microscopy. They learn to evaluate modern spectroscopic and microscopic methods on the basis of a fundamental theoretical understanding and to use them specifically to answer biological questions. In the seminar, students learn how to critically discuss and evaluate research results. In the exercises, students gain insights into hypothesis-driven experimental research and deepen their methodological skills.

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: Methods of molecular and cellular biophysics, advanced spectroscopic and microscopic techniques.

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: In accordance with the general examination regulations according to § 14.
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-BP2	**Master Module Biophysics: Fundamentals of Bioimaging and Data Processing** *German module title:* *Mastermodul Grundlagen der biologischen Bildgebung und Datenbearbeitung*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Biophysics and CellNanOs
Credit Points 12 CP	**Module frequency** Lecture and Seminar each winter term, Exercises each winter term by arrangement	**Committee responsible for the module** School of biology/chemistry – executive board

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 methods of sample preparation, acquisition and data analysis.

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-MB1	**Master Module Microbiology: Microbial Pathomechanisms** *German module title:* *Mastermodul Mikrobiologie: Mikrobielle Pathomechanismen*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	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

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-NB	**Master Module Neurobiology: Neurobiology** *German module title:* *Mastermodul Neurobiologie: Neurobiologie*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-NBP	**Master Module Biophysics: NanoBioPhysics** *German module title:* *Mastermodul Biophysik: NanoBioPhysik*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.					
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-ÖK1	**Master Module Ecology: Experimental Ecology and Evolution** *German module title:* *Mastermodul Ökologie: Experimentelle Ökologie und Evolution*	English

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	School of biology/chemistry – executive board

Learning objectives

The module focuses on the use of laboratory-based model systems to answer fundamental ecological and evolutionary biological questions. In particular, populations and communities of unicellular organisms are used to experimentally investigate selected topics. Small groups deal with the relevant literature on a specific topic and independently develop hypotheses, which are then tested in extensive series of experiments. The results obtained are statistically evaluated and presented. In doing so, they learn about the entire process of gaining scientific knowledge and deepen their scientific and methodological skills. You will train to summarize and present the results of your own project in the form of an English-language presentation and to engage constructively and critically with the presentations of other participants.

Content

LECTURE: Adaptation and specialization, trade-offs, evolutionary genetics, evolvability, phenotypic plasticity, cooperation and conflict, unity and level of selection, origin and maintenance of sexuality, ecology and evolution of synergistic and antagonistic interactions, methods of synthetic ecology and experimental evolutionary research, basics of statistics.

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: Carrying out scientific projects on a selected topic.

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: In accordance with the general examination regulations according to § 14.					
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-ÖK2	**Master Module Ecology: Theoretical Ecology and Evolution** *German module title:* *Mastermodul Ökologie: Theoretische Ökologie und Evolution*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-PP	**Master Module Plant Physiology** *German module title:* *Mastermodul Pflanzenphysiologie*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Plant Physiology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	School of biology/chemistry – executive board

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 topics from subfields of the specialty within plant physiology.
SEMINAR: Selected, current primary research literature from the special field of the department.
LABORATORY: Selected experiments from different subfields, presentation of own results in English.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	4		none	Oral examination (45 min) on all topics of the module.
2nd Component:					
Seminar	1	2	Approved Presentation. Presence and participation is obligatory. Good performance (presentation, participation, questions) will result in a bonus for the final grade.		
3rd Component:					
Laboratory	5	6	Approved lab reports including additional literature work of about 10 pages overall. Presence is obligatory. Good performance will result in a bonus for the final grade.		

Examination requirements: Special scientific competences described under Contents will be examined.

Calculation of module grade, where relevant: Grade of the examination, boni for good presentation and seminar participation skills (presentation, questions) as well as good lab reports.

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

Retaking examinations to improve grades, where applicable: In accordance with the general examination regulations according to § 14.
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"
Prerequisites for Participation in this Module: Strong interest in the topic.

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

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 winter or summer term	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.					
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-TP	**Master Module Animal Physiology** *German module title:* *Mastermodul Tierphysiologie*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
8 SWS	1 semester	Lecturers in Animal Physiology
Credit Points	**Module frequency**	**Committee responsible for the module**
12 CP	Each winter term	School of biology/chemistry – executive board

Learning objectives

Students expand and deepen their scientific and methodological competences. They will be able to plan their own project on selected special topics, e.g. the function and regeneration of tissues and organs, carry out the experiments independently, analyse the results and present them in writing. In doing so, they learn to take into account the relevant and current literature in the respective subject area. You will practise understanding and giving presentations in English as well as critically reflecting on original scientific literature in English. You will learn to present the results of your own summarise and present the results of their own projects in written form and in an English-language presentation.

Content

LECTURE: Selected chapters from different subfields of animal physiology.
SEMINAR: With the help of review articles and primary literature, in-depth technical and methodological-theoretical knowledge from different sub-areas is 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 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: Specific scientific competences in the aspects of animal physiology 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: In accordance with the general examination regulations according to § 14.
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-NMM-ZO1	**Master Module Zoology: Molecular Developmental Biology** *German module title:* *Mastermodul Zoologie: Entwicklungsgenetik*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-SPV-x **x = BC1_v1 or BC2_v1 or BO or BP1 or BP2 or BP3 or MB1 or MZB or NB or NBP or ÖK1 or ÖK2 or PP or SB or TP or ZO1**	**In-Depth Lecture (Lecture of Module BIO-NMM-x)** *German module title:* *Spezialvorlesungsmodul (Vorlesung zu Modul BIO-NMM-x)*	English

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	School of biology/chemistry – executive board

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:					
1st component (lecture) decoupled from module BIO-NMM-x.	2	4	none	none	As specified for the 1st component (lecture) of module BIO-NMM-x.

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". The module cannot be taken if the lecture it contains is used as a component in any other module taken.

Prerequisites for Participation in this Module:

Identifier	Module title	Language
BIO-NMM	**Master Module (General Description)** *German module title:* *Mastermodul (allgemeine Beschreibung)*	English

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	School of biology/chemistry – executive board

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: In accordance with the general examination regulations according to § 14.					
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells". 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	Language
BIO-SPV	**In-Depth Lecture** *German module title:* *Spezialvorlesungsmodul*	English

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	School of biology/chemistry – executive board

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.

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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells"

Prerequisites for Participation in this Module:

Identifier	Module title	Language
CHE-AtomBond	**Atomic Structure and Chemical Bond** *German module title:* *Atombau und Chemische Bindung*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
1 SWS	1 semester	Lecturers of Physical Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
2 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

Students will gain comprehensive overview of the topics atomic structure and chemical bonds.

Content

Frontiers of classical physics; wave–particle duality; uncertainty principle; quantum-mechanical operators; Schrödinger equation; wave functions; quantization of physical quantities; oscillators; potentials; atom models and electronic structure of atoms; interatomic interaction models; electron spins; chemical bonds and molecular orbitals; aromaticity; term symbols; rotational and vibrational spectra; electronic and vibronic transitions; Franck-Condon principle.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: SynSV					
Seminar	1 SWS	2 CP	None	None	Study project or oral examination (30) or written examination (60) or MC examination (60) or seminar talk (30) or poster presentation (20)

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

In accordance with the general examination regulations according to § 14.

Module Applicability

MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module

None; participation in the module is not possible if this module was considered for the Bachelor degree.

Identifier	Module title	Language
CHE-Biocon_v1	**Bioconjugates** *German module title:* *Biokonjugate*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
3 SWS	1 semester	Lecturers of Organic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
4 CP	Each academic year	School of biology/chemistry – executive board

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. The students will also 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. 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

Absorption-based assays (colorimetric assays with nucleic acids, metal ions, amines, thiols, and proteins, cell viability assays, chromogenic enzyme assays). Immunoassays (antibody structure and function, radioimmunoassays, binding equilibria and enzyme kinetics, enzyme-linked immunosorbent assays). Protein structure and the bioconjugation reactions for amines and thiols. Fluorescence-based assays (fluorescence steady-state and lifetime spectroscopy, energy transfer, anisotropy, time-resolved fluorescence (TRF) assays). Assay design (protease and kinase assays including data evaluation and statistical analysis). Bioconjugates and assays with nucleic acids (oligonucleotide synthesis and labelling, FiSH, molecular beacons, PCR and rtPCR, aptamers). Functionalization of planar and spherical surfaces (DLVO theory, polymer, silica, and gold surfaces, quantum dots, chromatography supports, liposomes). Biotin-(strep)avidin. Bioorthogonal chemistry (oximes, hydrazones, Staudinger ligation, azide-alkyne cycloadditions).

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: BioconV					
Lecture	2 SWS	3 CP	None	None	Written examination (60) or MC examination (60) or oral examination (30)
2nd Component: BioconÜ					
Exercise	1 SWS	1 CP	Solving the exercises	None	Included in component 1

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 In accordance with the general examination regulations according to § 14.
Module Applicability MSc "Nanosciences – Materials, Molecules and Cells".
Prerequisites for Participation in this Module None

Identifier	Module title	Language
CHE-BioInorg	**Bioinorganic Chemistry** *German module title:* *Bioanorganische Chemie*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
2 SWS	1 semester	Lecturers of Inorganic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
3 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

Students know the function of metals and metal proteins in life processes. They are able to link models from inorganic and organic chemistry (knowledge transfer). On completion of the module, students will have a sound overview of the subject and detailed specialist knowledge of the issues covered.

Content

The contents of the lecture are based on the current textbooks of bioinorganic chemistry, such as the textbook by W. Ternes „Biochemie der Elemente“, W. Kaim, B. Schwederski „Bioanorganische Chemie“ and J. Berg, J. Tymoczko, L. Styer „Biochemie“. The following topics are typically covered: Chemical bonding in complex compounds. Metals and metal complexes. Coordination chemistry concepts and their application in biological processes. Biological ligands. Biological functions of inorganic elements. Metals in life processes. Catalysis of biological reactions. Chemical equilibria and catalysis. Biomineralization. Bioinorganic chemistry of toxic metals.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: SynSV					
Lecture	2 SWS	3 CP	None	None	Written examination (60) or oral examination (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

In accordance with the general examination regulations according to § 14.

Module Applicability

MSc "Nanosciences – Materials, Molecules and Cells"; participation in the module is not possible if this module was considered for the Bachelor degree.

Prerequisites for Participation in this Module

None

Identifier	Module title	Language
CHE-ChaInOrg	**Characterization Methods in Inorganic Chemistry** *German module title:* *Charakterisierungsmethoden in der Anorganischen Chemie*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
2 SWS	1 semester	Lecturers of Inorganic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
3 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

The students will acquire a well-founded, subject-related overview knowledge as well as detailed specialist knowledge in the covered scientific fields.

Content

Typical contents include powder diffraction, thermogravimetry, DSC, atomic absorption spectroscopy, atomic emission spectroscopy, X-ray fluorescence analysis, electron microscopy (SEM and TEM), IR spectroscopy, UV-vis spectroscopy, fluorescence spectroscopy, dynamic light scattering.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: ChaInOrg					
Lecture	2 SWS	3 CP	None	None	Written examination (60) or oral examination (30)

Examination requirements

Basic knowledge in inorganic chemistry, 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

In accordance with the general examination regulations according to § 14.

Module Applicability

MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module

None; participation in the module is not possible if this module was considered for the Bachelor degree.

Identifier	Module title	Language
CHE-FunPA	**Applications of Functional Polymers** *German module title:* *Anwendungen funktionaler Polymere*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
7 SWS	1 semester	Lecturers of Organic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
8 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

The students to recognize that functional polymers are macromolecules that exhibit special properties in addition to their function as materials. The module describes application examples from the diverse world of functional polymers.

Content

Lecture: 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
1st Component: FunPA-lecture					
Lecture	2 SWS	3 CP	None	Participation in exercises, report of practical course	Written examination (60)
2nd Component: FunPA-prac					
Practical course	5 SWS	5 CP	Compulsory attendance; conducting experiments; written protocols of the experiments	None	Written Report

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

In accordance with the general examination regulations according to § 14.

Module Applicability

MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module
Successful participation in module CHE-FunPS.

Identifier	Module title	Language
CHE-FunPS	**Synthesis of Functional Polymers** *German module title:* *Synthese funktionaler Polymere*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
3 SWS	1 semester	Lecturers of Organic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
4 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives
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.

Content
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).

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: FunPS-lecture					
Lecture	2 SWS	3 CP	None	Participation in exercises, report of practical course	Written examination (60)
2nd Component: FunPS-excercises					
Exercises	1 SWS	1 CP	Processing of exercise tasks	None	Included in component 1

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
In accordance with the general examination regulations according to § 14.

Module Applicability
MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module
None

Identifier	Module title	Language
CHE-LumiM	**Luminescent Metal Complexes** *German module title:* *Lumineszierende Metallkomplexe*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
5 SWS	1 semester	Lecturers of Inorganic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

Students will systematically learn knowledge of luminescent transition metal complexes (coordination complexes) in terms of the theory, synthesis, structures, photophysical and photochemical properties, as well as their applications in different fields, e.g. in bioanalysis, photodynamic therapy, energy conversion, and photocatalysis. Depending on the application requirements, their combination with nanomaterials will be needed. Additionally, advanced spectroscopic methods will be introduced, which will allow the students to understand the interactions of light with the electronic ground state and excited state of photoactive metal complexes. Students will obtain these expert knowledges on the lectures and the corresponding exercises, while the practical seminar will offer the students the opportunity to gain some insight into the advanced research topics and states.

Content

THEORY: ligand field theory of coordination metal complexes, coordination geometries, octahedral and tetrahedral complexes, charge-transfer transitions, Jablonski-diagram, Tanabe-Sugano diagram, electrochemistry, electron transfer, Marcus theory, Dexter-type energy transfer, Förster resonance energy transfer, photon upconversion, proton transfer;

SYNTHESIS: organic synthesis of different ligands and their complexation with metals;

Photophysical and photochemical properties: UV/Vis absorption, luminescence emission and excited state lifetime, luminescence quantum yields, ground state and excited state reactivity;

APPLICATIONS: Investigation of photoluminescent metal complexes as biolables for bioimaging, as optical indicators for chemical sensing (different sensing mechanisms), and as photosensitizer for photodynamic therapy (generation of singlet oxygen); using photoactive metal complexes for sensitizing photon upconversion, and as photocatalysts for driving chemical reactions with light. These photoactive metal complexes can be combined with nanostructures to make them applicable under ambient conditions. Different nanostructures will be introduced.

SPECTROSCOPY: UV/Vis/NIR absorption, steady-state and time-resolved photoluminescence spectroscopy, transient-absorption spectroscopy.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: LumiMV					
Lecture	2 SWS	3 CP	None	Participation in exercises, passing 50 % of the exercise tasks, passing the literature presentation	Written examination (60) or oral examination (30)
2nd Component: LumiMÜ					
Exercise	1 SWS	1 CP	Solving the exercises	None	Included in component 1
3rd Component:LumiMS					
Practical seminar	2 SWS	2 CP	Literature presentation	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 In accordance with the general examination regulations according to § 14.
Module Applicability MSc "Nanosciences – Materials, Molecules and Cells".
Prerequisites for Participation in this Module None

Identifier	Module title	Language
CHE-NanoP	**Properties of Nanocrystalline Materials** *German module title:* *Eigenschaften nanokristalliner Materialien*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
3 SWS	1 semester	Lecturers of Inorganic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
4 CP	Each academic year	School of biology/chemistry – executive board

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

Properties of nanocrystalline solids, optical and electronic characteristics of nanocrystals from semiconductors, metals, and doted isolators; magnetic properties of nanocrystals, supra paramagnetism.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method)
1st Component: Properties nanocrystalline solids L					
Lecture	2 SWS	3 CP	None	None	Written examination (120) or oral examination (60)
2nd Component: Properties nanocrystalline solids E					
Exercise	1 SWS	1 CP	Completion of exercise tasks	None	Included in component 1

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

In accordance with the general examination regulations according to § 14.

Module Applicability

MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module

None

Identifier	Module title	Language
CHE-NanoS	**Synthesis of Nanocrystalline Materials** *German module title* *Synthese nanokristalliner Materialien*	English

SWS (contact hours per week during semester)	Module duration	Authorised module representative
7 SWS	1 semester	Lecturers of Inorganic Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
8 CP	Each academic year	School of biology/chemistry – executive board

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: 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)
1st Component: Synthesis nanocrystalline solids L					
Lecture	2 SWS	3 CP	None	None	Written examination (120) or oral examination (60)
2nd Component: Nano Prac					
Practical course	5 SWS	5 CP	Compulsory attendance; completion 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

In accordance with the general examination regulations according to § 14.

Module Applicability MSc "Nanosciences – Materials, Molecules and Cells"
Prerequisites for Participation in this Module Successful participation in module CHE-NanoP

Identifier	Module title	Language
CHE-NMRSpec	**NMR Spectroscopy** *German module title:* *NMR-Spektroskopie*	English

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**
3 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

The students will acquire advanced and detailed knowledge about NMR spectroscopy.

Content

Physical basic principles of NMR spectroscopy, nuclear angular momentum and nuclear magnetic moment, nuclear spin, nuclei in a static magnetic field, gyromagnetic ratio, Larmor precession, spin-lattice relaxation and transverse relaxation, spin energy in a magnetic field, resonant frequency, chemical shift, basics of an NMR experiment, pulse NMR, free induction decay (FID), and Fourier transformation (FT-NMR), overview of spectral parameters, NMR of 31P, 19F, 15N, internal end external reference, 1H NMR shifts of organic compounds, inductive and mesomeric effects, diamagnetic and paramagnetic shielding, magnetic anisotropy, McConnell equation, ring current effects, pulse angle, phase coherence, 13C NMR shifts of organic compounds, spectra and molecular structure, spin-spin coupling, AX system, fine coupling, styrene, benzyl alcohol, AX2 system, Fermi constant, H,H-coupling and chemical structure, C,H-coupling and chemical structure, sign of coupling constants, C,C-coupling and chemical structure, Dirac vector model, first-order and higher-order spectra, multiplicity rules, AXn systems, AMX systems, coupling between protons and other nuclei, peak intensity, 13C NMR and digital resolution, signal integration, C,H- and H,H-coupling constants, geminal and vicinal H,H-coupling, Karplus curve, gauche/trans coupling, ^{4}J and ^{5}J coupling, spin decoupling, spectra simulation, iteration and analysis, spind decoupling in 1H and 13C NMR, spin-lattice relaxation (T1) in 13C NMR, spin-spin relaxation (T2), inversion recovery technique, nuclear Overhauser effect (NOE), pulse field gradient (PFG) NMR, J-modulated spin echo, PFG-spin echo, polarization transfer, DEPT experiments, TOCSY, 1D INADEQUATE, 1H,1H-COSY, long-range COSY, J-resolved 2D NMR, 2D INADEQUATE, heteronuclear 2D NMR, HETCOR, C,H-COSY, inverse 2D HETCOR: HSQC and HMQC, (gs-)HMBC, 2D exchange-NMR (EXSY), NOESY, ROESY

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: SynSV					
Lecture	2 SWS	3 CP	None	None	Written examination (60) or oral examination (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

In accordance with the general examination regulations according to § 14.

Module Applicability

MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module

None; participation in the module is not possible if this module was considered for the Bachelor degree.

Identifier	Module title	Language
CHE-Self	**Self-Organizing Systems** *German module title:* *Selbstorganisierende Systeme*	English

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	School of biology/chemistry – executive board

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
1st 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	Study project or oral examination (45) or written examination (60) or MC examination (60) or seminar talk (40) or poster presentation (20)
2nd Component: Seminar with laboratory course					
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

In accordance with the general examination regulations according to § 14.

Module Applicability MSc "Nanosciences – Materials, Molecules and Cells".
Prerequisites for Participation in this Module None

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

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	School of biology/chemistry – executive board

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 exercises related to the experiments of the lab course and exercises on advanced topics, which provide an insight into contemporary and seminal original research from the scientific literature.

Content

Theory of 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). Host-guest complexes and molecular recognition (crown ethers, cyclodextrins, calixarenes, cucurbiturils, and others). Binding thermodynamics and kinetics (binding equilibria, NMR, isothermal titration calorimetry, optical-spectroscopic methods). Supramolecular photochemistry (absorption, fluorescence steady-state and lifetime spectroscopy, energy and electron transfer, exciplexes, sensors, photoswitches). Self-assembly and dynamic covalent chemistry. Supramolecular topology (catenanes, rotaxanes, and molecular knots) and functional supramolecular systems and machines. Supramolecular chemistry of biomembranes and membrane transporters. Supramolecular catalysis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: SupraV					
Lecture	2 SWS	3 CP	None	Participation in exercises, passing 50% of the exercise tasks, report of practical course	Written examination (120) or MC examination (120) or oral examination (30)
2nd Component: SupraÜ					
Exercise	1 SWS	1 CP	Solving the exercises	None	Included in component 1
3rd Component:SupraPrac					
Practical course	2 SWS	2 CP	Exercises and 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 In accordance with the general examination regulations according to § 14.
Module Applicability MSc "Nanosciences – Materials, Molecules and Cells".
Prerequisites for Participation in this Module None

Identifier	Module title	Language
CHE-SynComp	**Important Synthetic Organic Compounds** *German module title:* *Wichtige Synthetische Organische Verbindungen*	English

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**
3 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

Students will have a comprehensive overview of important substance classes of synthetic organic compounds. This includes the structures, applications, and the synthesis of pertinent examples from the different substance classes.

Content

AROMATIC COMPOUNDS: Concept and criteria for aromaticity (resonance stabilization, reactivity, ring current effect, Hückel theory and Frost circles); polycyclic aromatic hydrocarbons: naphthalene, anthracene, binaphthol, and others; Clar's rule; fullerenes; carcinogenicity; optical spectroscopic properties (absorption, fluorescence, circular dichroism); non-benzylic arenes: aromatic ions (cyclopropenyl, cyclopentadienyl, tropylium, and others), azulene, annulenes; heteroaromatic compounds: furan, pyrrole, thiophene, and others; porphyrins: porphine, porphyrinogen, Rothemund synthesis, McDonald synthesis, porphycene (McMurray reaction), corrole (sulfur extrusion), calix[4]pyrrole

DYE CHEMISTRY: Chromaticity, color, and color vision; colorimetry and color spaces; chromophores; auxochromes; push-pull chromophores; solvatochromism; halochromism; textile dyeing (natural dyes, azo dyes, carbonyl dyes, textile dyeing techniques, optical brighteners); polymethine dyes (cyanines, merocycanines, streptocyanines, hemicyanines, oxonoles); diaryl- and triarylmethine dyes (crystal violet, Coomassie Brilliant Blue), phthalein and xanthene dyes (phenolphthalein, fluorescein, rhodamine); quinonimine, azine, and acridine dyes; photochromic dyes; fluorescence microscopy; antibody labelling; pigments (phthalocyanines, rylenes, photosensitization)

POLYMER CHEMISTRY: Chain growth reactions (radical polymerization, cationic polymerization, anionic polymerization, coordinative polymerization); step growth polymerization (polycondensation, polyaddition); properties of polymers (degree of polymerization, molecular weight distribution and determination, thermal properties, mechanical properties

LIQUID CRYSTALS: Mesogens and mesophases; calamitic mesophases (nematic, smectic, cholesteric); optical properties of liquid crystals (birefringence, polarization microscopy and liquid crystal textures, photonic crystals); thermal properties of liquid crystals (phase transitions, sequence rule); synthesis of calamitic mesogens with organometallic coupling reactions; columnar mesophases; liquid crystal displays; chirality of mesophases (circular dichroism and optical rotary dispersion)

MACROCYCLIC HOST MOLECULES: Host-guest chemistry; crown ethers; cryptands; cyclophanes; calixarenes; cryptands; cucurbiturils

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component: SynSV					
Lecture	2 SWS	3 CP	None	None	Written examination (60) or oral examination (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 In accordance with the general examination regulations according to § 14.
Module Applicability MSc "Nanosciences – Materials, Molecules and Cells".
Prerequisites for Participation in this Module None; participation in the module is not possible if this module was considered for the Bachelor degree.

Identifier	Module title	Language
CHE-GMM1	**Master Module (General Description)** *German module title:* *Mastermodul (allgemeine Beschreibung)*	German or English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
5 SWS	1 semester	Lecturers in Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
6 CP	Winter or summer term	School of biology/chemistry – executive board

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 of chemistry and nanoscience.
SEMINAR: With the help of reviewing articles and primary literature, in-depth technical and methodological-theoretical knowledge from different sub-areas of chemistry and nanoscience is acquired.
LAB COURSE / PRACTICAL EXERCISES: Selected experiments and/or practical exercises from different sub-areas of chemistry and nanoscience.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Lecture	2	3			Study project or oral examination (45) or written examination (60) or MC examination (60) or seminar talk (40) or poster presentation (20)
2nd Component:					
Seminar	1	1	Approved presentation. Since exercise-relevant content will be presented and discussed, regular active participation in the seminar is required.		

3rd Component:					
Lab course/practical Exercises	2	2	Approved protocols and/or 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: Content and qualification aims of the module.					
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: In accordance with the general examination regulations according to § 14.					
Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells".					
Prerequisites for Participation in this Module: Admission/participation is 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.					

Identifier	Module title	Language
CHE-IDL1	**In-Depth Lecture 1** *German module title:* *Spezialvorlesungsmodul 1*	German or English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
3 SWS	1 semester	Lecturers in Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
4 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

Acquisition of specialised scientific competences. Acquisition of specialised knowledge of selected topics in chemistry and nanoscience.

Content

LECTURE: Selected current topics from different subfields of chemistry and nanoscience.
EXERCISES: Exercises on the selected current topics addressed in the lecture.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Special non-modular lectures in chemistry or nanoscience or a lecture decoupled from a Master's module.	2	3	None	None	Study project or oral examination (30) or written examination (60) or MC examination (60) or seminar talk (40) or poster presentation (20)
2nd Component:					
Exercise	1	1 CP	Processing of exercise tasks	None	Included in the lecture

Examination requirements: Specialised scientific competences on selected current topics in chemistry and nanoscience 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module: Admission/participation is 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.

Identifier	Module title	Language
CHE-IDL2	**In-Depth Lecture 2** *German module title:* *Spezialvorlesungsmodul 2*	German or English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
2 SWS	1 semester	Lecturers in Chemistry
Credit Points	**Module frequency**	**Committee responsible for the module**
3 CP	Each academic year	School of biology/chemistry – executive board

Learning objectives

Acquisition of specialised scientific competences. Acquisition of specialised knowledge of selected topics in chemistry and nanoscience.

Content

LECTURE: Selected current topics from different subfields of chemistry and nanoscience.
EXERCISES: Exercises on the selected current topics addressed in the lecture.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Special non-modular lectures in chemistry or nanoscience or a lecture decoupled from a Master's module.	2	3	None	None	Study project or oral examination (30) or written examination (60) or MC examination (60) or seminar talk (40) or poster presentation (20)

Examination requirements: Specialised scientific competences on selected current topics in chemistry and nanoscience 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: In accordance with the general examination regulations according to § 14.

Module Applicability: MSc "Nanosciences – Materials, Molecules and Cells".

Prerequisites for Participation in this Module: Admission/participation is 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.

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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

School of Mathematics/Computer Science/Physics

Modul PHY-AP: Hands-On Physics	
Identifier	PHY-AP
Module title	Hands-On Physics
German module title	Angewandte Physik
Authorised module representative	Dean of Studies
Qualification objectives	• Students of physics, chemistry or biology will learn to design, construct, operate and validate physical measurement setups based on electronic and optical components in the Arduino/Raspberry Pi world and using self-made tools fabricated by 3D printing • Acquisition of scientific knowledge in English • Self-competencies such as self and time management, initiative, motivation, diligence, accuracy, persistence, self-confidence
Contents	The module consists of a lecture (2 SWS) and a highly integrated lab course (2 SWS). Both lecture and lab course have two parts: A) General Sensing with Electronic Readout, B) Optical Technologies Lecture contents: A. physical properties and the international unit system (SI); basics of measurement theory, including errors and noise; basics of electronic devices, interfaces, and communication protocols B. introduction to optical concepts and technologies; light sources and detectors; spectrometers Lab course contents: A. setting up a simple Arduino experiment; measuring temperature and assessing errors; using various sensor types with electronic readout; designing and executing your own Arduino experiment B. generating and detecting light; using 3D printed components to mount your own optics; electronic read-out using Raspberry Pi; deploying data over the internet
Module components including CP (LP) information	Lecture with integrated lab course (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 term
Course credits	Regular attendance to both lecture and lab course
Required pre-examination achievements	Successful completion of the lab course
Type of examination by continuous assessment	Two reports on self-designed experiments (one each for part A and B)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of reports (70%) and lab course performance (30%)
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“. Participation in the module is not possible if this module was considered for the Bachelor degree.

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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-BMMP-M-15: Methods of Biomacromolecular Physics	
Identifier	PHY-BMMP-M-15
Module title	Methods 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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-ETS: Electronic Transport and Spintronics	
Identifier	PHY-ETS
Module title	Electronic Transport and Spintronics
German module title	Elektronischer Transport und Spintronik
Authorised module representative	Dean of Studies
Qualification objectives	• Consolidation of knowledge in experimental solid-state physics, based on exemplary advanced topics • Acquisition of physics knowledge in English • 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: • AC conductivity in metals (skin depth, plasma frequency) • Band structure of solids (Fermi sphere, DOS, Landau bands, mass of crystal electron) • Boltzmann equation for electronic transport (scattering, semiclassical model) • Semiconductor devices (Diodes, MOSFET, solar cells) • Quantum transport (ballistic transport, QHE, constant interaction model, QDs as sensors) • Spintronics for sensors (GMR, AMR)
Module components including CP (LP) information	Lecture and homework (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	Regular attendance, homework
Required pre-examination achievements	Successful completion of the homework
Type of examination by continuous assessment	Written (120 min) or oral (30 min) exam
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Modul PHY-NQS-L: Nano- and Quantum Sensing — Lecture	
Identifier	PHY-NQS-L
Module title	Nano- and Quantum Sensing — Lecture
German module title	Vorlesung zur Nano- und Quantensensorik
Authorised module representative	Dean of Studies
Qualification objectives	• Students of physics, chemistry or biology will learn about cutting-edge technologies in ultra-high-resolution nanoscale and/or quantum sensing and spectrometry (see contents) • The lecture will offer acquisition of scientific knowledge in English • If desired, assignments can be handed out to promote self-study • Students can reinforce self-competencies such as self and time management, initiative, commitment, motivation, diligence, accuracy, persistence, self-confidence
Contents	This lecture will introduce topics involving cutting-edge technologies in ultra-high-resolution nanoscale and/or quantum sensing and spectrometry **Specific contents: (**exemplary, may be adapted to interests of audience) • introduction to sensing at the nanoscale • spatial, spectral and temporal resolution and sensitivity • from mechanical sensors to scanning-probe techniques • optics: from microscopes and spectrometers to functional super-resolution techniques • biological and chemical sensors; from assays to property assessment • spin-based techniques and quantum sensing; applications in magnetic resonance, magnetometry, and measurement of derived quantities
Module components including CP (LP) information	Lecture (6 CP)
CP of the module	6
SWS (hours per week during the semester) of the module	4
Duration of the module	One semester
Frequency with which the course is offered	Once each academic year
Course credits	Regular attendance
Required pre-examination achievements	Content and qualification aims of the module. Reasonable performance in assigned homework (if applicable).
Type of examination by continuous assessment	Lecture: oral exam (30 mins)
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of oral 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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-NQS-LC: Nano- and Quantum Sensing Lab Course	
Identifier	PHY-NQS-LC
Module title	Nano- and Quantum Sensing — Lab Course
German module title	Praktikum zur Nano- und Quantensensorik
Authorised module representative	Dean of Studies
Qualification objectives	• Students of physics, chemistry or biology will learn about cutting-edge technologies in ultra-high-resolution nanoscale and/or quantum sensing and spectrometry (see contents) • Students can reinforce self-competencies such as self and time management, initiative, commitment, motivation, diligence, accuracy, persistence, self-confidence
Contents	The lab course provides hands-on experience with nano- and/or quantum sensing. **Specific contents: (**exemplary, to be adapted to interests of audience) • Quantum materials preparation I: endohedral fullerenes (ion implantation, HPLC, encapsulation) • Quantum materials preparation II: diamond color centers (ion implantation, surface conditioning, nano-patterning) • Electron spin resonance (cw and/or pulsed) of endohedral fullerenes • Optically detected magnetic resonance using diamond color censors • Integrating hard- and software for sensors
Module components including CP (LP) information	Lab Course (3 CP)
CP of the module	3
SWS (hours per week during the semester) of the module	2
Duration of the module	One semester (typically in 5 blocks of 6 hrs)
Frequency with which the course is offered	Anytime upon agreement
Course credits	Willing participation and reasonably successful performance of lab tasks
Required pre-examination achievements	Content and qualification aims of the module
Type of examination by continuous assessment	One or more written result reports, depending on actual course program
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Grade of report(s) (70%) and participation (30%)
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-NQS-S: Seminar on Nano- and Quantum Sensing	
Identifier	PHY-NQS-S
Module title	Nano- and Quantum Sensing — Seminar
German module title	Seminar zur Nano- und Quantensensorik
Authorised module representative	Dean of Studies
Qualification objectives	• Students of physics, chemistry or biology will learn about cutting-edge technologies in ultra-high-resolution nanoscale and/or quantum sensing and spectrometry (see contents) • The seminar will enable students to look for, read, present, and discuss current research literature about a given topic (in English) • Students can reinforce self-competencies such as self and time management, initiative, commitment, motivation, diligence, accuracy, persistence, self-confidence
Contents	The seminar will focus on selected issues and original research papers in the field of nano- and/or quantum sensing. **Specific contents: (**exemplary, ma be adapted to interests of audience) • Advanced scanning-probe based techniques • Super-resolution techniques • Fiber-optic sensing • Bio-assay sensing • Quantitative biological and/or chemical sensors • Spin-based quantum sensing (materials and/or methods) • Quantum magnetometry • Measurement of derived quantities in modern sensing
Module components including CP (LP) information	Seminar (3 CP)
CP of the module	3
SWS (hours per week during the semester) of the module	2
Duration of the module	One semester
Frequency with which the course is offered	Once or twice each academic year
Course credits	Seminar talk
Required pre-examination achievements	Regular attendance and active feedback for other seminar participants
Type of examination by continuous assessment	Preparation of original seminar talk on topic agreed upon with instructor, subsequent discussion with other participants
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Talk (70%) and preparation (30%)
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-NUMP_v1: Computational Physics	
Identifier	PHY-NUMP_v1
Module title	Computational Physics
German module title	Numerische Physik
Authorised module representative	Dean of Studies
Qualification objectives	• Students of physics, chemistry or biology will learn to use the Python programming language to implement standard numerical methods for solving typical problems in their disciplines (see contents below). This is essential for theoretical work, but it can also be of great help for analyzing experimental data quantitatively, e.g. during a lab course. • No prior programming experience is necessary but a willingness to study Python basics on your own is. • The course will help connecting mathematical methods to the natural science problems, enabling you to choose appropriate numerical tools • Acquisition of scientific knowledge in English. • Self-competencies such as self and time management, initiative, motivation, diligence, accuracy, persistence, self-confidence.
Contents	The module consists of a lecture (2 SWS) and highly integrated exercises (2 SWS) that have to be taken together. The exercises are discussed among participants and sharing ideas and code snippets is encouraged. Specific contents: • basics of numerical methods, fundamentals of Python • introduction to numerical methods for analysis and linear algebra • introduction to modern (stochastic) simulation techniques
Module components including CP (LP) information	Lecture with integrated 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	Once every academic year
Course credits	
Required pre-examination achievements	Successful completion of a number of the exercises
Type of examination by continuous assessment	30 min. oral presentation (a) of own exercise solutions OR (b) of a lengthier programming project; presentation using own laptop is allowed
Examination requirements	Complete contents of module and qualification objectives
Calculation of module grade	Arithmetic mean of all grades
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“. Participation in the module is not possible if this module was considered for the Bachelor degree.

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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-OFP-P-15: Laboratory Course: Surface Science	
Identifier	PHY-OFP-P-15
Module title	Laboratory Course: Surface Science
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc „Nanosciences - Materials, Molecules and Cells“

Modul PHY-PCMS-15: Computational Materials Science	
Identifier	PHY-PCMS-15
Module title	Computational Materials Science
German module title	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	School of Mathematics/Computer Science/Physics-executive board
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 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
Frequency with which the course is offered	Annually in either winter or summer term
Course credits	Regular attendance, homework
Required pre-examination achievements	Successful completion of the homework
Type of examination by continuous assessment	Oral exam (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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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 $\leq$ 4.0 ('sufficient' or better)
Retaking to improve grades	Not allowed
Decision-making body for the module	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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 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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“

Modul PHY-SDS-15: Stochastic Dynamical Systems	
Identifier	PHY-SDS-15
Module title	Stochastic 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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	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∈{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	School of Mathematics/Computer Science/Physics-executive board
Use of module	MSc “Nanosciences - Materials, Molecules and Cells“
Prerequisites for participation in this module	Possible prerequisites see under respective “examination regulations”

Identifier	Module title	Language
NAN-RS	**Research Specialization** *German module title* *Fachliche Spezialisierung*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
9 SWS	At least 5 weeks	Lecturers in biology, chemistry and physics
Credit Points 12 CP	**Module frequency** By individual arrangement	**Committee responsible for the module** School of biology/chemistry -executive board School of Mathematics/Computer Science/Physics-executive board

Learning objectives

Students acquire advanced knowledge and methodological competence in
- literature research using literature databases,
- dealing with scientific literature in a specialized research topic in nanoscience – materials, molecules and cells,
- in-depth knowledge in a specialized research topic in nanoscience – materials, molecules and cells,
- related experimental techniques and/or characterization methods and/or theoretical methods,
- self-competencies such as time management, initiative, perseverance, tenacity.

Content

Scientific literature research using scientific databases and/or selection of scientific literature based on their relevance and/or studying of scientific literature and/or practical, experimental work and/or theoretic model development and simulation addressing a scientific problem from the current research areas of the research groups participating in the Master course “Nanoscience – Materials, Molecules and Cells”; documentation of the literature research and the own scientific work.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Full-day laboratory work and or theoretical work/simulation and/or field work totalling at least 5 weeks.	8	12		None	Written report or seminar talk or poster presentation
2nd Component:					
Seminar	1	Included in the 1st component	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: 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 § 14 of the general examination regulations (allgemeine Prüfungsordnung).

Module Applicability: MSc “Nanosciences – Materials, Molecules and Cells”.

Prerequisites for Participation in this Module: according to the applicable examination regulations. Admission/participation is 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.

Identifier	Module title	Language
NAN-RC	**Research Course** *German module title* *Forschungsarbeit*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
10 SWS	1 semester	Lecturers in biology, chemistry and physics
Credit Points 15 CP	**Module frequency** By individual arrangement	**Committee responsible for the module** School of biology/chemistry -executive board School of Mathematics/Computer Science/Physics-executive board

Learning objectives

Students should demonstrate that they are able to work on a defined scientific problem. This includes 1) the development of the research question, 2) adequate dealing with scientific literature, 3) adequate application of scientific experimental or theoretical techniques, 4) data evaluation, 5) documentation and archiving of scientific data in a scientifically and methodologically correct way and 6) presentation, summarization and discussion of scientific results within a specified period of time.

Content

Practical and/or theoretic scientific work on a topic related to the research areas of one of the research groups involved in the Master course Nanoscience – Materials, Molecules and Cells. This includes 1) literature research, literature selection and a summary of the state of the art based on the relevant scientific literature, 2) application of experimental and/or theoretical scientific methods, 3) documentation and archiving of scientific data. The students will practice literature research, scientific writing, structuring and summarizing of scientific problems as well as correct referencing. 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:					
Full-day laboratory work and/or field work and/or theoretical work/simulation and self-study totalling at least 9 weeks	9	15		None	Written report or seminar talk or poster presentation
2nd Component:					
Seminar	1	Included in the 1st component	Consistent participation in the seminar and frequent communication with the supervisor	None	Included in 1st component

Examination requirements: Content and qualification aims of the module.

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 § 14 of the general examination regulations (allgemeine Prüfungsordnung).

Module Applicability: MSc “Nanosciences – Materials, Molecules and Cells”

Prerequisites for Participation in this Module: according to the applicable examination regulations. Admission/participation is 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.

Identifier	Module title	Language
NAN-Talks	**Talks in Biology, Chemistry, Nanoscience, Physics** *German module title* *Fachvorträge in Biologie, Chemie, Nanoscience und Physik*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
2 SWS	1-2 semester	Lecturers in biology, chemistry and physics
Credit Points 3 CP	**Module frequency** Each academic year by individual arrangement	**Committee responsible for the module** School of biology/chemistry -executive board School of Mathematics/Computer Science/Physics-executive board

Learning objectives

The students get in touch with current research topics in relevant research fields and the corresponding researchers. The students experience the presentation of scientific results in a professional scientific context.

Content

Scientific talks given by researchers in the fields of biology, chemistry, nanoscience and physics.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Scientific talks and/or Master defences and/or PhD defences	2	3	Compulsory attendance of 14 talks in the fields of biology, chemistry, nanoscience and physics; at least 3 talks in each discipline.	None	None

Examination requirements: None

Calculation of module grade, where applicable: None

Guidelines for passing the module, where applicable: None

Retaking examinations to improve grades, where applicable: None

Module Applicability: MSc “Nanosciences – Materials, Molecules and Cells”

Prerequisites for Participation in this Module: None

Identifier	Module title	Language
NAN-SW	**Seminar on Scientific Working** *German module title* *Anleitung zu selbstständigem wissenschaftlichen Arbeiten*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
1 SWS	1 semester	Lecturers in biology, chemistry and physics
Credit Points Included in NAN-MT	**Module frequency** By individual arrangement	**Committee responsible for the module** School of biology/chemistry -executive board School of Mathematics/Computer Science/Physics-executive board

Learning objectives

The students will enhance their ability to plan, conduct, document, present, discuss and archive scientific work as required to elaborate a thesis under appropriate consideration of scientific literature and applicable scientific standards. The students will, moreover, learn how to structure and write a thesis meeting the standards of scientific writing.

Content

This module is an integral and mandatory component of the Master thesis in the course Nanoscience – Materials, Molecules and Cells. The contents will be presented in a way specific to the research group in which the students carry out their Master theses. The contents are based on the requirements resulting from the research topic of the Master thesis and the research field of the research group, in which the Master thesis is carried out.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Seminar	1	Included in module NAN-MT	Regular attendance	none	none

Examination requirements: none

Calculation of module grade, where applicable: none

Guidelines for passing the module, where applicable: none

Retaking examinations to improve grades, where applicable: none

Module Applicability: MSc “Nanosciences – Materials, Molecules and Cells”

Prerequisites for Participation in this Module: registration for the Master thesis

Identifier	Module title	Language
NAN-MT	**Master Thesis** *German module title* *Masterarbeit*	English

SWS (contact hours per week during semester)	Module duration	Authorized module representative
	1 semester	Lecturers in biology, chemistry and physics
Credit Points 30	**Module frequency** By individual arrangement	**Committee responsible for the module** School of biology/chemistry -executive board School of Mathematics/Computer Science/Physics-executive board

Learning objectives

1st component: Students will train their scientific competences including 1) the planning of a research project, 2) the appropriate use and consideration of scientific literature, 3) experimental, theoretical and empiric scientific methods relevant to the topic or the thesis and 5) scientific project management. The students will enhance their ability to document and to archive scientific results and their competence in the structuring, presentation and discussion of scientific results. They will improve their competence in scientific writing; this includes the appropriate citation of scientific literature, the summary of the relevant state-of-the-art and the application of appropriate scientific standards.
2nd component: Oral presentation of own scientific results to the scientific public and discussion of own scientific results with the scientific public.

Content

1st component: Experimental and/or empirical and/or theoretical research project addressing a scientific problem chosen by mutual agreement with the thesis supervisor. Writing of a thesis under consideration of the subject-specific standards of scientific writing.
2nd component: Oral presentation and defense of the results of the Master thesis.

Module components including CP information	SWS	CP	Course Credits	Module prerequisites	Continuous assessment examination method
1st Component:					
Master thesis		28	Participation in module NAN-SW	None	Master thesis according to the requirements of the applicable examination regulation
2nd Component:					
Master defence		2	Submission of written Master thesis	None	Seminar talk

Examination requirements: according to the applicable examination regulations.

Calculation of module grade, where applicable: arithmetic average of the grades of the module components weighted with the number of credit points ascribed to the components.

Guidelines for passing the module, where applicable: according to the applicable examination regulations.

Retaking examinations to improve grades, where applicable: according to the applicable examination regulations.

Module Applicability: MSc “Nanosciences – Materials, Molecules and Cells”.

Prerequisites for Participation in this Module: according to the applicable examination regulations.