



**Master**

**Programmes**

**Chemistry  
Life Science  
Nanoscience**

**Module guide - December 2019**

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## **Qualification goals for the master programmes Chemistry, Life Science and Nanoscience**

### **Qualification goals for the Master's Programme Chemistry**

The master's programme spans 4 semesters. It is consecutive, builds on the bachelor's programme and comprises research-oriented advanced studies in the chemistry majors of Inorganic, Organic and Physical Chemistry, as well as in the elective areas of Biochemistry/Cellular Chemistry and Chemical Materials Science or other electives qualifying for professional work. Thus, there are extensive possibilities for individual academic prioritization. In the selected chemistry courses, the students are systematically introduced to the international research level. A master's thesis of 6 – 9 months follows the completion of the selected advanced courses. The study programme concludes with interdisciplinary oral examinations in the chemistry majors as well as the elective subject.

Participants of this study programme are expected to acquire the relevant competence to work as professional chemists in industry, research institutes, and in the private as well as in the public service sectors. Their knowledge, their understanding of chemical/material relationships and their ability to apply the latter will enable them to effectively and responsibly perform demanding tasks in production, research and development as well as in operational organization, to develop their knowledge independently, and to familiarize themselves flexibly with new areas and tasks.

The subsequent professional activity of the graduates of the Konstanz Bachelor's/Master's Programmes Chemistry is typically geared to research and development tasks in a wide variety of chemical fields, which is why interdisciplinary and/or multidisciplinary skills are generally emphasized as key criteria for success. The objective of the Konstanz Bachelor's/Master's Programmes Chemistry is therefore to qualify the students for challenging current research and development tasks, in particular for scientific and practical development projects in cutting-edge areas of chemistry in which diverse core areas of chemistry intersect with each other or neighbouring disciplines. To realize this goal, the structure of the Konstanz bachelor's/master's programme is scientifically coherent and offers a wide range of selection options for neighbouring disciplines.

### **Qualification goals for the Master's Programmes Life Science**

The objective of the study programme Life Science is to provide a solid and ambitious scientific education by combining the curricular contents of biology and chemistry, enabling students to acquire special competence in the fields of modern chemical biology, biological chemistry, biochemistry and related molecular life science disciplines, building on robust scientific foundations in chemistry and biology alike. Participants of this study programme acquire a qualification profile required for modern pharmaceutical research and are, if they wish to pursue further advanced studies, equally qualified for the options of doctorates in biology or in a life-science-oriented field of chemistry. Thanks to the well-founded basic education in chemistry as well as biology, the students absorb the specific ways of thinking of both disciplines from the very first semesters of their studies. Thus, they grow up to be scientifically bilingual, so to speak. This makes the Life Science study programme unique in terms of its concept throughout Germany.

The Life Science syllabus is closely intermeshed with the Biological Sciences and Chemistry programmes, integrating corresponding modules from both.

The study programme comprises a six-semester bachelor's programme and a subsequent four-semester master's programme. To lay sound scientific foundations in both biology and chemistry, the study and examination plan for the bachelor's programme is very specifically defined. The master's programme, by contrast, offers a wide range of freely selectable options from the curriculum of in-depth modules in biology and chemistry, thus making a pronounced individual prioritization possible.

The objective of the master's programme is to prepare the students for careers in university and non-university basic research (doctorate) or in biotechnological or industrial research, or alternatively for tasks in service areas (e.g. environmental authorities, consulting firms) in which sound scientific knowledge in areas related to life science is required. Thanks to the wide-ranging and individually differentiated training, graduates can choose between numerous professional fields.

### **Qualification goals for the Master's Programme Nanoscience**

The Nanoscience study programme provides students with sound skills in the field of manufacture and examination of materials and a well-grounded understanding of properties and functional principles of materials.

Practical training in the laboratory plays an important role in addition to the acquisition of theoretical knowledge. Students of the Master's Programme Nanoscience acquire additional, interdisciplinary qualifications. Through the interplay of theoretical knowledge and practical activities, the students gain skills in the field of problem solving they can also apply in other areas. They will also focus on how to present their results.

The Nanoscience study programme is of an interdisciplinary nature, focusing on the methodology of preparative synthesis in all relevant areas of chemistry and the understanding of physical-chemical relationships alike, followed by the development of broad expertise in the field of material chemistry.

Links to other subjects such as physics, mathematics and the field of transferable skills are established. The interdisciplinary character of the study programme is strongly expanded in the master's programme as many modules from the field of physics are included.

The objective of the master's programme is to prepare the students for careers in university and non-university basic research (doctorate). Graduates will find work in the electrical industry, e.g. in companies that produce micro-components, with manufacturers of instruments in measurement and sensor technology, as well as in the development of optical or medical equipment. They can also find jobs in companies in the ceramic and chemical industries, or in metal construction companies and foundries. Graduates conduct research and develop new materials such as plastics, but also biomaterials, paints and varnishes. Thanks to the wide-ranging and individually differentiated training, numerous further professional fields are likewise open to the graduates.

## Advanced Organic Chemistry – Lecture

### Study Programme

Master Chemistry (OC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The final grade is the grade for the written exam.

**Lecturer** Prof. Dr. T. Gaich, Prof. Dr. A. Marx, Prof. Dr. V. Wittmann

**Educational objectives** In-depth-knowledge in synthetic planning; strategy and retrosynthetic planning. Application of these concepts to complex natural products. Understanding of reaction mechanisms, and their application to multi-step synthesis. Insights in photochemical principles and reactions. NMR spectra interpretation for structure elucidation

**Teaching content** Special focus on rearrangement reactions; reactive intermediates and photochemistry. NMR spectra interpretation and structure elucidation with one- and two-dimensional NMR-techniques using MestreNova (bring your own laptop).

**Forms of teaching/  
Amount of SWS** Lecture 4 SWS

<b>Work load</b>	Lectures: 15 weeks × 4 h/week	60 h
	Preparation 1.5 h/contact hour	90 h
	Preparation for the final examination	30 h
		180 h

**Examination and unit completion** Written exam

**Prerequisites** Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience

**Language** English (German on request)

**Time slot and frequency** Winter term

<b>Advanced Organic Chemistry – Lab course</b>							
<b>Study Programme</b> Master Chemistry (OC), Master Life Science, Master Nanoscience							
<b>Credits</b>	6 ECTS						
<b>Duration</b>	4 weeks (full-time)						
<b>Module grade</b>	The grade is assigned according to the written lab report and the practical work performance during lab work.						
<b>Educational objectives</b>	The lab course is designed as an individual project within a research group. The students get expertise in experimental techniques in the field of Advanced Organic Chemistry. They master to work on a research project independently, to analyze results quantitatively and to give interpretations on basis of the experimental results. In addition, they are able to communicate their results in scientific discussions and to summarize the lab work in a written report.						
<b>Teaching content</b>	The lab course consists of an individual project within a research group.  The lab course can be performed in the research groups Gaich, Marx or Wittmann.						
<b>Forms of teaching/ Amount of SWS</b>	Research internship						
<b>Work load</b>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%;">Lab work</td> <td style="text-align: right;">160 h</td> </tr> <tr> <td>Written report</td> <td style="text-align: right;"><u>20 h</u></td> </tr> <tr> <td></td> <td style="text-align: right;">180 h</td> </tr> </table>	Lab work	160 h	Written report	<u>20 h</u>		180 h
Lab work	160 h						
Written report	<u>20 h</u>						
	180 h						
<b>Examination and unit completion</b>	Lab work, written report						
<b>Prerequisites</b>	Completion of the lecture Biopolymer Chemistry (before or after the lab course)						
<b>Language</b>	English (German on request)						
<b>Time slot and frequency</b>	On appointment. The number of lab course participants is limited.						

## Advanced Physical Chemistry – Lecture

### Study Programme

Master Chemistry (PC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** Graded exercise sheets

**Lecturer** Prof. Dr. Karin Hauser, Prof. Dr. M. Drescher, Prof. Dr. C. Peter, Prof. Dr. Andreas Zumbusch

**Educational objectives** The students know how to apply thermodynamics, statistical thermodynamics, quantum chemistry, spectroscopy, kinetics, and intermolecular interactions. They master the development and application of simple models, know how to formulate the models mathematically, and are able to gain insight into the chemical-physical nature of problems. The students can quantitatively analyze results from experiments in organic and inorganic chemistry, biochemistry, and molecular biology.

**Teaching content** The course will recapitulate and consolidate material from the Bachelor level. In contrast to the courses on the Bachelor level, a special emphasis will now be laid on application of the important concepts to practical problems. For this purpose, we will use simple models which give insight into the nature of the problems and allow their quantitative analysis.

#### a) Basics

Short recapitulation of the basics:

- estimation of orders of magnitude
- principles of probability calculus, approximations
- fundamental terms of thermodynamics: heat, work, energy, entropy, free energy, three laws of thermodynamics
- fundamentals of quantum mechanics: atomic wavefunctions, Hamilton operator, particle in a box, harmonic oscillator, rotator, molecular bonds
- Boltzmann distribution

#### b) Systems

Description of (statistical) models for the description of molecular systems:

- simple gases, liquids, and solids, heat capacity
- chemical equilibria, chemical potential
- equilibria between solids, liquids, gases
- solutions
- phase transitions
- electrochemistry

#### c) Dynamic processes

- diffusion and flow
- chemical kinetics; transition states
- optical spectroscopy

**Forms of teaching/  
Amount of SWS** Lecture 3 SWS, exercise 1 SWS

**Work load**

Lecture:		
Contact hours	15 weeks × 3 SWS	45 h
Preparation	2h/contact hour	90 h
Exercise:		
Contact hours	15 weeks × 1 SWS	15 h

Preparation 2h/contact hour

30 h  
180 h

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<b>Examination and unit completion</b>	Graded exercise sheets and/or short tests
<b>Prerequisites</b>	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	Winter term

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## **Advanced Physical Chemistry – Lab course**

### **Study Programme**

Master Chemistry (PC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 4 Weeks

**Module grade** Seminar talk, written protocol

**Lecturer** Prof. Dr. Karin Hauser, Prof. Dr. M. Drescher, Prof. Dr. C.-Peter, Prof. Dr. Andreas Zumbusch

**Educational objectives** The lab course part of this course aims at giving the students the possibility to apply their knowledge gained in the lectures in practice by doing one type of modern molecular spectroscopy experiments. Specifically, we offer lab courses on time-resolved FT-IR spectroscopy, fluorescence spectroscopy, ultrafast optical spectroscopy, EPR spectroscopy.

**Teaching content** The 12-ECTS variant implies the successful accomplishment of the lab course that can be performed in the research groups Drescher, Hauser, Peter, or Zumbusch.

**Forms of teaching/  
Amount of SWS** 4 weeks (full-time) to 6 weeks (part-time) lab course

**Work load** Lab course: 160 h  
Seminar talk, preparation: 20 h  
180 h

**Examination and unit completion** Seminar talk and written protocol

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience / Master course „Advanced Physical Chemistry - Lecture“

**Language** English (German on request)

**Time slot and frequency** According to the agreement

<b>Biophysical Chemistry – Lecture</b>																						
<b>Study Programme</b> Master Chemistry (PC), Master Life Science, Master Nanoscience																						
<b>Credits</b>	6 ECTS																					
<b>Duration</b>	1 Semester																					
<b>Module grade</b>	The grade is assigned according to the final exam.																					
<b>Lecturer</b>	Dr. Guinevere Mathies, Prof. Dr. K. Hauser																					
<b>Educational objectives</b>	The students know how to apply the teaching content of the lectures in Physical Chemistry within the Bachelor study course, e. g. thermodynamics, statistical thermodynamics, quantum chemistry, spectroscopy, kinetics, and intermolecular interactions, to problems in biophysical chemistry. They master the development and application of simple models, know how to formulate the models mathematically, and are able to gain insight into the chemical-physical nature of problems within a biological framework. The students can quantitatively analyze results from important experiments in biophysical chemistry.																					
<b>Teaching content</b>	<p>The course will focus on the application of concepts and techniques from Physical Chemistry to practical problems in Life Science. The first part of the course will cover spectroscopic techniques that can provide information on structure and dynamics of biological systems. The second part of the course will focus on thermodynamic concepts and kinetic models to describe reactions of biological macromolecules. Applications in current research fields will be presented.</p> <p>Part I (Spectroscopic Techniques): Introduction of Structural Biology; Magnetic Resonance Spectroscopy, Solution NMR, Magic-Angle Spinning NMR; X-Ray Diffraction; Cryo-Electron Microscopy; Optical Spectroscopy, Fluorescence Microscopy, Super Resolution; Fluorescence Correlation Spectroscopy</p> <p>Part II (Thermodynamics &amp; Kinetics): Molecular Interactions; Energy and Entropy; Bioenergetics and Driving Forces; Membrane Transport; Molecular Recognition; Kinetics and Rates of Molecular Processes; Pathways and Transition States in Protein Folding</p>																					
<b>Forms of teaching/ Amount of SWS</b>	Lecture 2 SWS, exercise 2 SWS																					
<b>Work load</b>	<table> <tbody> <tr> <td>Lecture:</td> <td></td> <td></td> </tr> <tr> <td>Contact hours</td> <td>15 weeks × 2 SWS</td> <td>30 h</td> </tr> <tr> <td>Preparation</td> <td>2h/contact hour</td> <td>60 h</td> </tr> <tr> <td>Exercise:</td> <td></td> <td></td> </tr> <tr> <td>Contact hours</td> <td>15 weeks × 2 SWS</td> <td>30 h</td> </tr> <tr> <td>Preparation</td> <td>2h/contact hour</td> <td><u>60 h</u></td> </tr> <tr> <td></td> <td></td> <td>180 h</td> </tr> </tbody> </table>	Lecture:			Contact hours	15 weeks × 2 SWS	30 h	Preparation	2h/contact hour	60 h	Exercise:			Contact hours	15 weeks × 2 SWS	30 h	Preparation	2h/contact hour	<u>60 h</u>			180 h
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Preparation	2h/contact hour	<u>60 h</u>																				
		180 h																				
<b>Examination and unit completion</b>	Oral exam (30 minutes)																					
<b>Prerequisites</b>	Bachelor Chemistry or Bachelor Life Science or Bachelor Nanoscience																					
<b>Language</b>	English																					
<b>Time slot and frequency</b>	Winter semester																					

## **Biophysical Chemistry – Lab course**

### **Study Programme**

Master Chemistry (PC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The grade is assigned according to the lab work, written report and the colloquium.

**Lecturer** Dr. Guinevere Mathies, Prof. Dr. K. Hauser

**Educational objectives** The students have successfully accomplished the Biophysical Chemistry – Lecture. They apply their attained knowledge in the lab course. The lab course is designed as an individual project within a research group. The students get expertise in experimental techniques used to study biological systems. They master to work on a research project independently, to analyze results quantitatively and to give interpretations on a data-driven basis. In addition, they are able to summarize the lab work in a written report and to present the research project in a colloquium.

**Teaching content** The lab course consists of an individual project within a research group.

The lab course can be performed in the research groups Drescher, Hauser, Kovermann, Mathies, Peter or Zumbusch.

### **Forms of teaching/ Amount of SWS**

Research internship

<b>Work load</b>	Lab work	160 h
	Written report	10 h
	Preparation of the colloquium	<u>10 h</u>
		180 h

**Examination and unit completion** Lab work, written report, colloquium

**Prerequisites** Successful completion of the lecture Biophysical Chemistry

**Language** English

**Time slot and frequency** On appointment. The number of lab course participants is limited.

<b>Biopolymer Chemistry – Lecture</b>											
<b>Study Programme</b> Master Chemistry (OC), Master Life Science, Master Nanoscience											
<b>Credits</b>	6 ECTS										
<b>Duration</b>	1 Semester										
<b>Module grade</b>	The final grade is the grade for the written exam.										
<b>Lecturer</b>	Prof. Dr. A. Marx, Prof. Dr. V. Wittmann										
<b>Educational objectives</b>	Acquirement of a basic understanding of the synthesis, chemical manipulation and analysis of carbohydrates, peptides, proteins and nucleic acids. Particular emphasis will be placed on the synthesis, modification and understanding of the intrinsic properties of the biopolymers depicted above.										
<b>Teaching content</b>	The course communicates selected aspects of modern carbohydrate, peptide, protein and nucleic acids chemistry. Carbohydrates: structure, occurrence & properties, protecting groups, glycosylation reactions. Peptides & Proteins: structure and properties, chemical synthesis and modification, automated synthesis, modern conjugation chemistry. Proteomics: protein purification and identification by mass spectrometry, identification of post-translational modifications. Nucleic Acids: structure and properties, chemical synthesis of nucleosides and their analogues, automated DNA and RNA synthesis, conjugation, nucleosides and nucleic acids as drugs and drug targets.										
<b>Forms of teaching/ Amount of SWS</b>	Lectures 3h/week, Seminar 1 h/week										
<b>Work load</b>	<table border="0"> <tr> <td>Lectures: 15 weeks × 3 h/week</td> <td>45 h</td> </tr> <tr> <td>Seminar: 15 weeks × 1 h/week</td> <td>15 h</td> </tr> <tr> <td>Preparation 1.5 h/contact hour</td> <td>90 h</td> </tr> <tr> <td><u>Preparation for the final examination</u></td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </table>	Lectures: 15 weeks × 3 h/week	45 h	Seminar: 15 weeks × 1 h/week	15 h	Preparation 1.5 h/contact hour	90 h	<u>Preparation for the final examination</u>	<u>30 h</u>		180 h
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Preparation 1.5 h/contact hour	90 h										
<u>Preparation for the final examination</u>	<u>30 h</u>										
	180 h										
<b>Examination and unit completion</b>	Written exam										
<b>Prerequisites</b>	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience										
<b>Language</b>	English (German on request)										
<b>Time slot and frequency</b>	Summer term										

## **Biopolymer Chemistry – Lab course**

### **Study Programme**

Master Chemistry (OC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 4 weeks (full-time)

**Module grade** The grade is assigned according to the written lab report and the practical work performance during lab work.

**Lecturer** Prof. Dr. A. Marx, Prof. Dr. V. Wittmann

**Educational objectives** The lab course is designed as an individual project within a research group. The students get expertise in experimental techniques in the field of Biopolymer Chemistry. They master to work on a research project independently, to analyze results quantitatively and to give interpretations on basis of the experimental results. In addition, they are able to communicate their results in scientific discussions and to summarize the lab work in a written report.

**Teaching content** The lab course consists of an individual project within a research group.

The lab course can be performed in the research groups Marx or Wittmann.

**Forms of teaching/  
Amount of SWS** Research internship

<b>Work load</b>	Lab work	160 h
	Written report	<u>20 h</u>
		180 h

**Examination and unit completion** Lab work, written report

**Prerequisites** Completion of the lecture Biopolymer Chemistry (before or after the lab course)

**Language** English (German on request)

**Time slot and frequency** On appointment. The number of lab course participants is limited.

## Computational Chemistry – Lecture

### Study Programme

Master Chemistry (PC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The grade is assigned according to the final exam.

**Lecturer** Prof. Dr. C. Peter

### Educational objectives

The students will obtain an overview of different aspects of the use of computers in chemistry and learn to apply common computational tools via practical exercises.

Students will get to know different computer simulation methods for molecular systems – from the quantum chemical to the classical level. They will learn to apply the concepts introduced in the modules Physical Chemistry 1-4 to the numerical investigation of chemical and biomolecular problems, i.e. to solve electronic structure problems on a computer and to simulate statistical mechanical ensembles of atoms and molecules.

The main focus of the course will be on the link between statistical mechanics and computer simulations, i.e. on classical models and simulation methods.

The students will get acquainted with the basic concepts of molecular dynamics simulations and learn to apply them with the help of practical exercises. They will carry out simulations of simple systems such as liquids, electrolytes and (bio)molecules in solution. The students will learn to assess the applicability as well as the limitations of the models and methods. The general concepts of advanced simulation techniques (computation of free energies, enhanced sampling methods, multiscale simulations) will be introduced, so that students are able to follow, assess and carry out computer simulation studies for practical applications in chemistry, chemical biology and nanoscience.

In the practical exercises accompanying the lecture, students will get acquainted with the Linux operating system, some standard computer simulation software, and the use of different computational tools to analyze and visualize data as well as molecular systems.

No prior knowledge of programming languages is required.

- In the 12 ECTS-variant (see lab course), the students will gain insight into to-date research in the field of computational chemistry, biomolecular modeling and computational materials chemistry

### Teaching content

Methods and models in theoretical chemistry on different levels of resolution:

- a short introduction to computational quantum chemistry with examples
- classical simulation methods, computational statistical mechanics, the molecular dynamics simulation algorithm; controlling the system (thermostats, barostats, ...)
- classical forcefields: intra- and intermolecular interactions; solvent models; the treatment of electrostatic interactions
- analysis of classical simulations: computation of thermodynamic, structural and dynamic properties
- methods to compute free energies
- advanced sampling methods
- concepts of multiscale simulations and scale-bridging

Practical exercises:

- simulation of simple model systems (simple liquids/solutions/mixtures)
- technical aspects of molecular simulation (boundary conditions; energy conservation; controlling the systems; practical aspects of model implementation: forcefields; treatment of electrostatic interactions)
- applications in chemical biology and materials science (peptide folding; crystallization from melt and solution; (bio)polymer-ion interactions ...)

- use of computational tools to set up and display biological and materials science systems (including the use of databases such as the ProteinDataBank)
- data analysis (scripting tools; python; ...)

<b>Forms of teaching/ Amount of SWS</b>	Lecture 2 SWS, Computer exercises 2 SWS	
<b>Work load</b>	Lecture: 15 weeks x 2 SWS	30 h
	Preparation 1.5 h/contact hour	45 h
	Computer exercise: 15 weeks x 2 SWS	30 h
	Preparation 1.5 h/contact hour	45 h
	Preparation of the final colloquium	30 h
		<u>180 h</u>
<b>Examination and unit completion</b>	Oral exam	
<b>Prerequisites</b>	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience	
<b>Language</b>	English (German on request)	
<b>Time slot and frequency</b>	Summer term	

## Computational Chemistry – Lab course

### Study Programme

Master Chemistry (PC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS
<b>Duration</b>	1 Semester
<b>Module grade</b>	The grade is assigned according to the oral project presentation and the documentation of the results.
<b>Lecturer</b>	Prof. Dr. C. Peter
<b>Educational objectives</b>	<p>The students will obtain an overview of different aspects of the use of computers in chemistry and learn to apply common computational tools via practical exercises.</p> <p>Students will get to know different computer simulation methods for molecular systems – from the quantum chemical to the classical level. They will learn to apply the concepts introduced in the modules Physical Chemistry 1-4 to the numerical investigation of chemical and biomolecular problems, i.e. to solve electronic structure problems on a computer and to simulate statistical mechanical ensembles of atoms and molecules.</p> <p>The main focus of the course will be on the link between statistical mechanics and computer simulations, i.e. on classical models and simulation methods. The students will get acquainted with the basic concepts of molecular dynamics simulations and learn to apply them with the help of practical exercises. They will carry out simulations of simple systems such as liquids, electrolytes and (bio)molecules in solution. The students will learn to assess the applicability as well as the limitations of the models and methods. The general concepts of advanced simulation techniques (computation of free energies, enhanced sampling methods, multiscale simulations) will be introduced, so that students are able to follow, assess and carry out computer simulation studies for practical applications in chemistry, chemical biology and nanoscience.</p> <p>In the practical exercises accompanying the lecture, students will get acquainted with the Linux operating system, some standard computer simulation software, and the use of different computational tools to analyze and visualize data as well as molecular systems.</p> <p>No prior knowledge of programming languages is required.</p>

<b>Teaching content</b>	<p>Methods and models in theoretical chemistry on different levels of resolution:</p> <ul style="list-style-type: none"> <li>- a short introduction to computational quantum chemistry with examples</li> <li>- classical simulation methods, computational statistical mechanics, the molecular dynamics simulation algorithm; controlling the system (thermostats, barostats, ...)</li> <li>- classical forcefields: intra- and intermolecular interactions; solvent models; the treatment of electrostatic interactions</li> <li>- analysis of classical simulations: computation of thermodynamic, structural and dynamic properties</li> <li>- methods to compute free energies</li> <li>- advanced sampling methods</li> <li>- concepts of multiscale simulations and scale-bridging</li> </ul> <p>Practical exercises:</p> <ul style="list-style-type: none"> <li>- simulation of simple model systems (simple liquids/solutions/mixtures)</li> <li>- technical aspects of molecular simulation (boundary conditions; energy conservation; controlling the systems; practical aspects of model implementation: forcefields; treatment of electrostatic interactions)</li> <li>- applications in chemical biology and materials science (peptide folding; crystallization from melt and solution; (bio)polymer-ion interactions ...)</li> </ul>
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- use of computational tools to set up and display biological and materials science systems (including the use of databases such as the ProteinDataBank)
- data analysis (scripting tools; matlab; ...)

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<b>Forms of teaching/ Amount of SWS</b>	Research Practical
<b>Work load</b>	Research practical: 180 h
<b>Examination and unit completion</b>	Oral presentation of the research practical period / documentation of results
<b>Prerequisites</b>	Computational chemistry course
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	Personal communication

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<b>Current Issues and Methods in Nanoscience – Lecture</b>													
<b>Study Programme</b> Master Chemistry, Master Life Science, Master Nanoscience													
<b>Credits</b>	6 ECTS												
<b>Duration</b>	1 Semester												
<b>Module grade</b>	The module grade is composed of the grade for the final exam (oral or written) and the grade for the oral presentation given during the seminar.												
<b>Lecturer</b>	Dr. K. Boldt												
<b>Educational objectives</b>	The course covers modern physical and physical-chemical methods, their scope, limits, and background, applied to the field of colloidal nanoscience. The course will enable the students to find the right combination of tools to address research questions. An overview over the current issues in nanoscience will be given with a focus on optical and electronic properties of nanocrystals.												
<b>Teaching content</b>	<p>The lecture addresses the following topics:</p> <ul style="list-style-type: none"> <li>• Basics and properties of Fourier transformation</li> <li>• Band structure of solids, <math>\mathbf{k} \cdot \mathbf{p}</math> theory</li> <li>• Plasmonics of metal nanoparticles, shape/function relationship</li> <li>• Carbon nanostructures, effects of low dimensionality</li> <li>• Semiconductor nanocrystals, size quantisation effect</li> <li>• Excitons, time-resolved optical spectroscopy, spectroelectrochemistry</li> <li>• Heterostructures, heterointerfaces, surface effects</li> <li>• Fluorescence quantum yield, fluorescence intermittency</li> <li>• Quantum dot lasers, charge carrier multiplication</li> <li>• Ion exchange, Doping of nanocrystals, MCD spectroscopy</li> <li>• Nanocrystal-based sensors, interaction between nanoparticles</li> <li>• Magnetic nanoparticles, magnetism on the nanoscale</li> </ul>												
<b>Forms of teaching/ Amount of SWS</b>	6 ECTS: Lecture (3 SWS), Seminar (1 SWS)												
<b>Work load</b>	<table> <tbody> <tr> <td>Lecture: 15 x 3 SWS</td> <td>45 h</td> </tr> <tr> <td>Seminar: 15 x 1 SWS</td> <td>15 h</td> </tr> <tr> <td>Preparation (L + S): 15 x 4 SWS</td> <td>60 h</td> </tr> <tr> <td>Preparation presentation</td> <td>30 h</td> </tr> <tr> <td>Preparation of final colloquium</td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </tbody> </table>	Lecture: 15 x 3 SWS	45 h	Seminar: 15 x 1 SWS	15 h	Preparation (L + S): 15 x 4 SWS	60 h	Preparation presentation	30 h	Preparation of final colloquium	<u>30 h</u>		180 h
Lecture: 15 x 3 SWS	45 h												
Seminar: 15 x 1 SWS	15 h												
Preparation (L + S): 15 x 4 SWS	60 h												
Preparation presentation	30 h												
Preparation of final colloquium	<u>30 h</u>												
	180 h												
<b>Examination and unit completion</b>	<p>Presentation (30 min.): the student presents a recent or seminal paper in the field. Particular focus is on clear presentation of scientific knowledge gain and giving the context in relation to the lecture.</p> <p>Final exam (30 min.): During the exam the student is confronted with an unknown paper or new data in context of and based on knowledge from the lecture.</p>												
<b>Prerequisites</b>	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience												
<b>Language</b>	English (German on request)												
<b>Time slot and frequency</b>	Winter term												

## **Current Issues and Methods in Nanoscience – Lab course**

### **Study Programme**

Master Chemistry, Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The grade is assigned in equal parts to a written lab report and the practical work performance during lab work.

**Lecturer** Dr. K. Boldt

**Educational objectives** The course covers modern physical and physical-chemical methods, their scope, limits, and background, applied to the field of colloidal nanoscience. The course will enable the students to find the right combination of tools to address research questions. An overview over the current issues in nanoscience will be given with a focus on optical and electronic properties of nanocrystals.

**Teaching content** In the practical part knowledge from the lecture (see lecture and seminar) shall be intensified by working on a current research project in a nanoparticle-related research project. In the seminar seminal and current publications relating to the topics of the lecture will be discussed.

**Forms of teaching/  
Amount of SWS** 6 ECTS: Lab rotation, one-on-one mentoring by a doctoral student or postdoc, support for writing the lab report

**Work load**

Practical lab work	150 h
Writing of lab report	30 h
	180 h

**Examination and unit completion** Lab report, composed of introduction, theoretical background, task definition, results and discussion, summary and outlook, and experimental details.

**Prerequisites** Taken part in the lecture and seminar. Passing the exam to the lecture is required to finish this module.

**Language** English or German

**Time slot and frequency** According to the agreement

<b>Dispersion Colloids in Research and Industry – Lecture</b>													
<b>Study Programme</b> Master Chemistry (OC), Master Life Science, Master Nanoscience													
<b>Credits</b>	6 ECTS												
<b>Duration</b>	1 Semester												
<b>Module grade</b>	Final grade is calculated as follows: lecture 2/3, seminar presentation 1/3												
<b>Lecturer</b>	Prof. Dr. A. Wittemann												
<b>Educational objectives</b>	The students acquire knowledge on dispersion colloids and their applications in science and technology.												
<b>Teaching content</b>	<p>General classification of colloids &amp; dispersion, particularly with regard to suspensions and emulsions:</p> <ul style="list-style-type: none"> <li>- Macroemulsions, miniemulsions and microemulsions (preparation of emulsions by various methods, emulsion stability and stabilization mechanisms, role of emulsifiers, theoretical concepts)</li> <li>- Synthesis of polymer dispersions (emulsion polymerization, dispersion polymerization, miniemulsion polymerization, <i>etc.</i>) from the lab to the industrial scale</li> <li>- Practical applications of polymer dispersions</li> <li>- Colloidal stability and appropriate ways to stabilize dispersed systems are of central importance.</li> </ul>												
<b>Forms of teaching/ Amount of SWS</b>	Lecture 3 SWS, seminar 1 SWS												
<b>Work load</b>	<table> <tbody> <tr> <td>Lecture: 15 weeks x 3 SWS</td> <td>45 h</td> </tr> <tr> <td>Preparation</td> <td>45 h</td> </tr> <tr> <td>Seminar: 15 weeks x 1 SWS</td> <td>15 h</td> </tr> <tr> <td>Preparation of the seminar presentation</td> <td>25 h</td> </tr> <tr> <td>Preparation for the final colloquium</td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>160 h</td> </tr> </tbody> </table>	Lecture: 15 weeks x 3 SWS	45 h	Preparation	45 h	Seminar: 15 weeks x 1 SWS	15 h	Preparation of the seminar presentation	25 h	Preparation for the final colloquium	<u>30 h</u>		160 h
Lecture: 15 weeks x 3 SWS	45 h												
Preparation	45 h												
Seminar: 15 weeks x 1 SWS	15 h												
Preparation of the seminar presentation	25 h												
Preparation for the final colloquium	<u>30 h</u>												
	160 h												
<b>Examination and unit completion</b>	Oral presentation (25 min) on a current topic of colloid science, final colloquium (40 min)												
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience: At the beginning of the course, the content of teaching is adapted to the current knowledge of the module participants.												
<b>Language</b>	English (German on request)												
<b>Time slot and frequency</b>	Winter term												

## **Dispersion Colloids in Research and Industry – Lab course**

### **Study Programme**

Master Chemistry (OC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS										
<b>Duration</b>	1 Semester										
<b>Module grade</b>	Final grade is calculated as follows: practical performance 1/3, oral presentation 1/3, written report 1/3										
<b>Lecturer</b>	Prof. Dr. A. Wittemann										
<b>Educational objectives</b>	The students get involved in an ongoing research project related to colloid science.										
<b>Teaching content</b>	Active involvement in an advanced research project in colloid science will help to train practical research skills.										
<b>Forms of teaching/ Amount of SWS</b>	Practical lab work by participation in a current research project Block course of 160 h – dates by arrangement										
<b>Work load</b>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">Lab course</td> <td style="text-align: right;">160 h</td> </tr> <tr> <td>Preparation of the lab course</td> <td style="text-align: right;">5 h</td> </tr> <tr> <td>Preparation of the oral presentation</td> <td style="text-align: right;">15 h</td> </tr> <tr> <td>Written report</td> <td style="text-align: right;"><u>20 h</u></td> </tr> <tr> <td></td> <td style="text-align: right;">200 h</td> </tr> </table>	Lab course	160 h	Preparation of the lab course	5 h	Preparation of the oral presentation	15 h	Written report	<u>20 h</u>		200 h
Lab course	160 h										
Preparation of the lab course	5 h										
Preparation of the oral presentation	15 h										
Written report	<u>20 h</u>										
	200 h										
<b>Examination and unit completion</b>	Oral presentation of the lab project (20 min), evaluation of the practical performance and the final report										
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience: Participation in the lecture Dispersion Colloids in Research and Industry (either before or in parallel with the lab course) or in any other course on Colloid Science										
<b>Language</b>	English (German on request)										
<b>Time slot and frequency</b>	According to the agreement										

<b>Gene Expression and Replication – Lecture</b>													
<b>Study Programme</b> Master Chemistry, Master Life Science, Master Nanoscience													
<b>Credits</b>	6 ECTS												
<b>Duration</b>	1 Semester												
<b>Module grade</b>	The grade reflects the result of the written exam.												
<b>Lecturer</b>	Prof. Dr. J. Hartig, Prof. Dr. A. Marx												
<b>Educational objectives</b>	The training course communicates detailed knowledge about the cellular processes of reading, writing, and maintaining genetic information from genes to proteins. A specific focus will be placed on understanding molecular mechanisms of the respective biochemical processes down to the atomic level.												
<b>Teaching content</b>	The lectures deal with the maintenance and expression of genetic information from replication to protein biosynthesis. The following topics will be discussed: Chemical and structural aspects of DNA, RNA, and genes; DNA replication; RNA repair, organisation of genes and genomes; transcription and its regulation, RNA processing, functional RNAs such as ribozymes, aptamers, riboswitches, RNA interference, the genetic code, ribosomal translation, expansion of the genetic code.												
<b>Forms of teaching/ Amount of SWS</b>	Lectures 3 SWS, Seminar 2 SWS												
<b>Work load</b>	<table> <tbody> <tr> <td>Lectures: 15 weeks x 3 SWS</td> <td>45 h</td> </tr> <tr> <td>Self-study 1 h / h lectures</td> <td>45 h</td> </tr> <tr> <td>Seminar: 15 weeks x 2 SWS</td> <td>30 h</td> </tr> <tr> <td>Self-study 1 h / h seminar.</td> <td>30 h</td> </tr> <tr> <td>Preparation for examination</td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </tbody> </table>	Lectures: 15 weeks x 3 SWS	45 h	Self-study 1 h / h lectures	45 h	Seminar: 15 weeks x 2 SWS	30 h	Self-study 1 h / h seminar.	30 h	Preparation for examination	<u>30 h</u>		180 h
Lectures: 15 weeks x 3 SWS	45 h												
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Preparation for examination	<u>30 h</u>												
	180 h												
<b>Examination and unit completion</b>	Final exam covering the topics presented in the lectures; oral presentation of a current topic within the seminar. The final grade is calculated from equal parts constituted of the performances of the exam and the oral presentation. It is necessary to pass both parts.												
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience												
<b>Language</b>	English												
<b>Time slot and frequency</b>	Winter term (usually taking place in a blocked modus in January – February)												

## **Gene Expression and Replication – Lab course**

### **Study Programme**

Master Chemistry, Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** Grade of the practical course and protocol

**Lecturer** Prof. Dr. J. Hartig, Prof. Dr. A. Marx

**Educational objectives** The training course communicates detailed knowledge about the cellular processes of reading, writing, and maintaining genetic information from genes to proteins. A specific focus will be placed on understanding molecular mechanisms of the respective biochemical processes down to the atomic level.

**Teaching content** The experimental part involves modern topics in chemical biology and molecular biology: student interns participate in research projects conducted in the involved research groups.

**Forms of teaching/  
Amount of SWS** Practical training by participation in current research projects

**Work load** Practical course: Lab work: 180 h

**Examination and unit completion** Successful participation in the practical training, documented by a written report about the experimental project

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English

**Time slot and frequency** According to the agreement

<b>High-resolution NMR spectroscopy directed to biological and biophysical applications – Lecture</b>	
<b>Study Programme</b> Master Chemistry, Master Life Science, Master Nanoscience	
<b>Credits</b>	6 ECTS
<b>Duration</b>	1 Semester
<b>Module grade</b>	Module grade corresponds to individual examination regarding this module.
<b>Lecturer</b>	Prof. Dr. M. Kovermann
<b>Educational objectives</b>	This course covers modern methods of high-resolution NMR spectroscopy. The successful participation will enable the students to answer both structural and dynamic questions arising from current protein research by using high-resolution NMR spectroscopy.
<b>Teaching content</b>	(i) Introduction and relation to adjacent spectroscopic methods (ii) Classical description of NMR, quantum-mechanical description of NMR (product operator formalism) (iii) Pulse sequences, one-dimensional and multi-dimensional experiments (iv) Homonuclear vs. heteronuclear experiments (v) Pulsed field gradients / solvent suppression / diffusion (vi) Dynamic NMR: relaxation, H/D exchange, Mexico, real time NMR, paramagnetic relaxation enhancement, conformational dynamics (vii) Structure NMR: chemical shift, NOE, dihedrals, residual dipolar coupling, hydrogen bonding, assignment strategies, structure calculation (viii) Edited/filtered experiments (ix) Titration experiments, higher molecular complexes (x) Understanding the relation structure ↔ dynamics ↔ function
<b>Forms of teaching/ Amount of SWS</b>	Lecture 3 SWS, Seminar 1 SWS
<b>Work load</b>	Lecture: 15 x 3 SWS 45 h Seminar: 15 x 1 SWS 15 h Preparation (L + S): 15 x 4 SWS 60 h Preparation presentation 30 h Preparation of final colloquium <u>30 h</u> 180 h
<b>Examination and unit completion</b>	Presentation 30 min. and final colloquium 30 min. (equally weighted)
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	Summer term

## **High-resolution NMR spectroscopy directed to biological and biophysical applications – Lab course**

### **Study Programme**

Master Chemistry, Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** Module grade corresponds to individual examination regarding this module.

**Lecturer** Prof. Dr. M. Kovermann

**Educational objectives** This course covers modern methods of high-resolution NMR spectroscopy. The successful participation will enable the students to answer both structural and dynamic questions arising from current protein research by using high-resolution NMR spectroscopy.

**Teaching content**

- (i) Introduction and relation to adjacent spectroscopic methods
- (ii) Classical description of NMR, quantum-mechanical description of NMR (product operator formalism)
- (iii) Pulse sequences, one-dimensional and multi-dimensional experiments
- (iv) Homonuclear vs. heteronuclear experiments
- (v) Pulsed field gradients / solvent suppression / diffusion
- (vi) Dynamic NMR: relaxation, H/D exchange, Mexico, real time NMR, paramagnetic relaxation enhancement, conformational dynamics
- (vii) Structure NMR: chemical shift, NOE, dihedrals, residual dipolar coupling, hydrogen bonding, assignment strategies, structure calculation
- (viii) Edited/filtered experiments
- (ix) Titration experiments, higher molecular complexes
- (x) Understanding the relation structure ↔ dynamics ↔ function

**Forms of teaching/  
Amount of SWS** Lab rotation / 8 SWS

**Work load** Lab rotation including written report or oral presentation: 180 h

**Examination and unit completion** Written report or oral presentation 30 min. (upon agreement)

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English (German on request)

**Time slot and frequency** According to the agreement

<b>Industrial Chemistry and Renewable Resources – Lecture</b>															
<b>Study Programme</b> Master Chemistry, Master Life Science, Master Nanoscience															
<b>Credits</b>	6 ECTS														
<b>Duration</b>	1 Semester														
<b>Module grade</b>	The overall score of this course is the grade of the colloquium (75 %) on the subject matter of the lecture and of the seminar presentation (25 %)														
<b>Lecturer</b>	Prof. Dr. S. Mecking														
<b>Educational objectives</b>	A knowledge and understanding of the relationships between products of the chemical industry and their raw materials basis														
<b>Teaching content</b>	Current and future sources of petrochemical and renewable raw materials; range; methods of recovery; workup and further processing; cracker; biorefinery; base chemicals; intermediates; products; case studies of catalytic processes; basic terms of process technology														
<b>Forms of teaching/ Amount of SWS</b>	Lecture, Seminar and Excursion. 4SWS														
<b>Work load</b>	<table border="0"> <tr> <td>Lecture and</td> <td>45 h</td> </tr> <tr> <td>Preparation and wrap-up 1h/contact hour</td> <td>45 h</td> </tr> <tr> <td>Preparation of seminar presentation</td> <td>45 h</td> </tr> <tr> <td>Excursion</td> <td>15 h</td> </tr> <tr> <td>Preparation for the final exam</td> <td>30 h</td> </tr> <tr> <td></td> <td><hr/></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </table>	Lecture and	45 h	Preparation and wrap-up 1h/contact hour	45 h	Preparation of seminar presentation	45 h	Excursion	15 h	Preparation for the final exam	30 h		<hr/>		180 h
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	<hr/>														
	180 h														
	Ca. 45 min exam on the subject matter of the lecture; seminar presentation.														
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience														
<b>Language</b>	English (German on request)														
<b>Time slot and frequency</b>	Summer and winter term														

## **Industrial Chemistry and Renewable Resources – Lab course**

### **Study Programme**

Master Chemistry, Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The module grade is based on the written report and the laboratory work

**Lecturer** Prof. Dr. S. Mecking

**Educational objectives** A knowledge and understanding of the relationships between products of the chemical industry and their raw materials basis

**Teaching content** Current and future sources of petrochemical and renewable raw materials; range; methods of recovery; workup and further processing; cracker; biorefinery; base chemicals; intermediates; products; case studies of catalytic processes; basic terms of process technology

**Forms of teaching/  
Amount of SWS** Practical laboratory placement, participating in a research project

**Work load** Practical laboratory work including data analysis and written report: 180 h

**Examination and unit completion** The report is due within three months of the completion of the laboratory work.

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English (German on request)

**Time slot and frequency** Summer and Winter term. According to individual agreement

<b>Metal-Organic Chemistry and Catalysis – Lecture</b>							
<b>Study Programme</b> Master Chemistry (IC), Master Life Science, Master Nanoscience							
<b>Credits</b>	6 ECTS						
<b>Duration</b>	1 Semester						
<b>Module grade</b>	Grade of the final examination (oral or written exam)						
<b>Lecturer</b>	Prof. Dr. R. Winter						
<b>Educational objectives</b>	The students obtain deeper insight into the field of metal-organic chemistry with particular emphasis on its application to homogeneous catalysis and modern synthesis. This includes elementary reactions of catalytic processes and methods applied for their mechanistic studies. They also learn about the typical catalysts employed in the most important transformations, their reactivities and modes of action as well as the scope and limitations of various catalysts.						
<b>Teaching content</b>	<ul style="list-style-type: none"> <li>• Basic reactions of catalytic transformations, relation between valence-electron count, coordination geometry and preferred reactivity patterns</li> <li>• Important classes of steering ligands in homogeneous catalysis: CO, olefins, phosphines and N-heterocyclic carbenes and their steric and electronic properties</li> <li>• Alkyl- and -aryl complexes: Synthesis, stabilities, decomposition pathways, Pd- and Ni-catalyzed C-C cross coupling reactions and their applications.</li> <li>• Olefin complexes: Synthesis, properties, catalytic hydrogenation, directed and enantioselective hydrogenation, chiral phosphine and diphosphine ligands for enantioselective hydrogenation</li> <li>• Cobalt- and rhodium phosphine complexes in hydroformylation; chemo- and regioselectivity, competing reactions, enantioselective hydroformylation, Fischer-Tropsch reaction</li> <li>• Carbene and carbyne complexes in olefin and alkyne metathesis, variations of olefin and alkyne metathesis</li> </ul>						
<b>Forms of teaching/ Amount of SWS</b>	Lecture						
<b>Work load</b>	<table> <tbody> <tr> <td>Lecture + seminar: 15 weeks × 5 SWS</td> <td>75 SWS</td> </tr> <tr> <td>Preparation / Learning: 1 h per contact hour</td> <td>75 SWS</td> </tr> <tr> <td>Preparation for examination</td> <td>30 SWS</td> </tr> </tbody> </table>	Lecture + seminar: 15 weeks × 5 SWS	75 SWS	Preparation / Learning: 1 h per contact hour	75 SWS	Preparation for examination	30 SWS
Lecture + seminar: 15 weeks × 5 SWS	75 SWS						
Preparation / Learning: 1 h per contact hour	75 SWS						
Preparation for examination	30 SWS						
<b>Examination and unit completion</b>	Oral exam of ca. 45 min or 2h written exam						
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience						
<b>Language</b>	English (German on request)						
<b>Time slot and frequency</b>	Summer term						

## Metal-Organic Chemistry and Catalysis – Lab Course

### Study Programme

Master Chemistry (IC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** Lab report (oral presentation in the group seminar)

**Lecturer** Prof. Dr. R. Winter

**Educational objectives** The students obtain deeper insight into the field of metal-organic chemistry with particular emphasis on its application to homogeneous catalysis and modern synthesis. This includes elementary reactions of catalytic processes and methods applied for their mechanistic studies. They also learn about the typical catalysts employed in the most important transformations, their reactivities and modes of action as well as the scope and limitations of various catalysts.

**Teaching content**

- Basic reactions of catalytic transformations, relation between valence-electron count, coordination geometry and preferred reactivity patterns
- Important classes of steering ligands in homogeneous catalysis: CO, olefins, phosphines and N-heterocyclic carbenes; steric and electronic properties
- Alkyl- and aryl complexes: Synthesis, stabilities, decomposition pathways, application in diverse Pd- and Ni-catalyzed C-C cross coupling reactions, applications.
- Olefin complexes: Synthesis, properties, catalytic hydrogenation, directed and enantioselective hydrogenation, chiral phosphine and diphosphine ligands for enantioselective hydrogenation
- Cobalt- and rhodium phosphine complexes in hydroformylation; chemo- and regioselectivity, competing reactions, enantioselective hydroformylation, Fischer-Tropsch reaction
- Carbene and carbyne complexes in olefin and alkyne metathesis, variations of olefin and alkyne metathesis

**Forms of teaching/ Amount of SWS** Practical course and participation in a research project involving catalytic transformations

**Work load**

Practical course	150 SWS
Oral report on practical course	30 SWS

**Examination and unit completion** Practical performance in the lab and oral presentation of the results in our group seminar

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English (German on request)

**Time slot and frequency** According to the agreement

<b>Molecular Spectroscopy – Lecture</b>									
<b>Study Programme</b> Master Chemistry (PC), Master Life Science, Master Nanoscience									
<b>Credits</b>	6 ECTS								
<b>Duration</b>	1 Semester								
<b>Module grade</b>	Oral exam								
<b>Lecturer</b>	Prof. Dr. K. Hauser, Prof. Dr. Malte Drescher, Prof. Dr. A. Zumbusch								
<b>Educational objectives</b>	The students shall acquire advanced knowledge in spectroscopy. They learn to describe the interaction of matter with light on different levels of spectroscopy: purely classical, semi-classical with a quantum mechanical treatment of the molecular states, density matrix formalism for the description of coherent spectroscopies such as NMR. Thus, the focus of the course is on laying the foundations for a broad range of different types of modern molecular spectroscopy, such as IR, NMR, EPR, and ultrafast optical spectroscopy.								
<b>Teaching content</b>	<p>Contents of the lecture (6-ECTS variant):</p> <ul style="list-style-type: none"> <li>classical description of the interaction between electromagnetic radiation and matter: Einstein coefficients, refractive index, line shapes, lifetimes, polarisability, Raman scattering</li> <li>incoherent spectroscopy: time-dependent perturbation theory of spectroscopic transitions, transition dipole moment, absorption and fluorescence spectroscopy, infrared-spectroscopy</li> <li>coherent spectroscopy: density representations in quantum mechanics, density matrix formalism, two-level system in ultrafast optical spectroscopy and magnetic resonance spectroscopy (NMR and EPR)</li> <li>depending on the previous knowledge of the students, the course will give brief introductions into Fourier transformations, description of waves, and matrix calculus</li> </ul>								
<b>Forms of teaching/ Amount of SWS</b>	Lecture 4 SWS								
<b>Work load</b>	<table> <tr> <td>Lecture: 15 weeks x 4 SWS:</td> <td>60 h</td> </tr> <tr> <td>Preparation and post-processing (1.5 h/contact hour):</td> <td>90 h</td> </tr> <tr> <td>Final exam preparation:</td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </table>	Lecture: 15 weeks x 4 SWS:	60 h	Preparation and post-processing (1.5 h/contact hour):	90 h	Final exam preparation:	<u>30 h</u>		180 h
Lecture: 15 weeks x 4 SWS:	60 h								
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Final exam preparation:	<u>30 h</u>								
	180 h								
<b>Examination and unit completion</b>	Oral exam (30 minutes)								
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience / Recommended: Master course „Advanced Physical Chemistry“								
<b>Language</b>	English (German on request)								
<b>Time slot and frequency</b>	Summer term								

## **Molecular Spectroscopy – Lab course**

### **Study Programme**

Master Chemistry (PC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS
<b>Duration</b>	1 Semester
<b>Module grade</b>	Seminar talk
<b>Lecturer</b>	Prof. Dr. K. Hauser, Prof. Dr. Malte Drescher, Prof. Dr. A. Zumbusch
<b>Educational objectives</b>	The lab course part of this course aims at giving the students the possibility to apply their knowledge gained in the lectures in practice by doing one type of modern molecular spectroscopy experiments. Specifically, we offer lab courses on time-resolved FT-IR spectroscopy, fluorescence spectroscopy, ultrafast optical spectroscopy, EPR spectroscopy.
<b>Teaching content</b>	The 12-ECTS variant implies the successful accomplishment of the lab course that can be performed in the research groups Drescher, Hauser or Zumbusch.
<b>Forms of teaching/ Amount of SWS</b>	4 weeks (full-time) to 6 weeks (part-time) lab course
<b>Work load</b>	Lab course: 160 h Seminar talk, preparation: <u>20 h</u> 180 h
<b>Examination and unit completion</b>	Seminar talk
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience / Recommended: Master course „Advanced Physical Chemistry“
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	According to the agreement

<b>Nanochemistry and -analytics – Lecture</b>									
<b>Study Programme</b> Master Chemistry (PC), Master Life Science, Master Nanoscience									
<b>Credits</b>	6 ECTS								
<b>Duration</b>	1 Semester								
<b>Module grade</b>	The module grade is composed of the grade for the final oral exam, the grade for the oral presentation given during the seminar and the grade for the practical.								
<b>Lecturer</b>	Prof. Dr. Helmut Cölfen								
<b>Educational objectives</b>	Formation, analytics and properties of nanoparticles with focus on analytics.								
<b>Teaching content</b>	Features of colloidal systems – size-dependent properties, synthesis of nanoparticles and size/shape control, nucleation and crystal growth, interface chemistry, stabilization and destabilization of nanoparticles, DLVO theory, colloidal forces, demands for analytics, analytical ultracentrifugation, static and dynamic light scattering, field-flow-fractionation, particle tracking microscopy, Taylor dispersion, optical and electron microscopy, atomic force microscopy, fast UV-VIS spectroscopy, global comparison and overview of analysis results from different techniques								
<b>Forms of teaching/ Amount of SWS</b>	Lecture + exercise + seminars 4 SWS (2V / 2Ü)								
<b>Work load</b>	<table border="0"> <tr> <td>Lecture + exercise: 15 Weeks × 4 SWS</td> <td>60 h</td> </tr> <tr> <td>Preparation and follow-up: 1h pro contact hour</td> <td>60 h</td> </tr> <tr> <td>Small lab training</td> <td>30 h</td> </tr> <tr> <td>Preparation for oral examination</td> <td>30 h</td> </tr> </table>	Lecture + exercise: 15 Weeks × 4 SWS	60 h	Preparation and follow-up: 1h pro contact hour	60 h	Small lab training	30 h	Preparation for oral examination	30 h
Lecture + exercise: 15 Weeks × 4 SWS	60 h								
Preparation and follow-up: 1h pro contact hour	60 h								
Small lab training	30 h								
Preparation for oral examination	30 h								
<b>Examination and unit completion</b>	About 45 minutes of oral examination								
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience								
<b>Language</b>	English (German on request)								
<b>Time slot and frequency</b>	Winter term								

## **Nanochemistry and -analytics – Lab course**

### **Study Programme**

Master Chemistry (PC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS
<b>Duration</b>	1 Semester
<b>Module grade</b>	The module grade is composed of the grade for the practical work (50 %) and the grade for the written or oral report (50%).
<b>Lecturer</b>	Prof. Dr. Helmut Cölfen
<b>Educational objectives</b>	Formation, analytics and properties of nanoparticles.
<b>Teaching content</b>	Actual research topics in nanochemistry and nanoanalytics including nanoparticle synthesis, nanoparticle self-organization, non-classical crystallization, synthesis and application of functional polymers, Bio- and bioinspired mineralization, crystallization control, nucleation and all analytical techniques from the lecture like analytical ultracentrifugation, static and dynamic light scattering, field-flow-fractionation, particle tracking microscopy, Taylor dispersion, optical and electron microscopy, atomic force microscopy, fast UV-VIS spectroscopy.
<b>Forms of teaching/ Amount of SWS</b>	Practical lab training
<b>Work load</b>	Practical lab training including report or oral presentation 210 h
<b>Examination and unit completion</b>	Report of the lab training resp. oral presentation (50 %) and performance in the laboratory (50 %)
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	According to the agreement

<b>Organometallic Chemistry of the Main Group Elements – Lecture</b>													
<b>Study Programme</b> Master Chemistry (IC), Master Life Science, Master Nanoscience													
<b>Credits</b>	6 ECTS												
<b>Duration</b>	1 Semester												
<b>Module grade</b>	Grades for the seminar presentation and the final exam. Both parts have to be passed and contribute equally to the final grade.												
<b>Lecturer</b>	Prof. Dr. A. Lorbach												
<b>Educational objectives</b>	<ul style="list-style-type: none"> <li>• Comprehensive knowledge of the activities and properties of main-group organyls</li> <li>• Insight into current research in the scientific field</li> <li>• Critical review of publications</li> </ul>												
<b>Teaching content</b>	<p>The students get an overview on important organometallic compounds of main group elements as well as their syntheses and applications. The properties and reactivities of the substance classes are discussed on the basis of selected examples. Another important aspect is the bonding situation in organometallic compounds. The course also covers analytical methods, which play a role in the characterization of organometallics.</p> <p>Because of their great importance for preparative organic and inorganic chemistry, the organyl compounds of lithium, magnesium, boron, aluminum, and silicon are presented in particular detail.</p> <p>In the seminar the participants present recent publications from the research field and critically discuss the results and conclusions.</p>												
<b>Forms of teaching/ Amount of SWS</b>	Lecture (3 h per week) und seminar (1 h per week)												
<b>Work load</b>	<table> <tbody> <tr> <td>Lecture: 15 × 3 h</td> <td>45 h</td> </tr> <tr> <td>Seminar: 15 × 1 h</td> <td>15 h</td> </tr> <tr> <td>Preparation and recapitulation (lecture + seminar): 15 × 4 h</td> <td>60 h</td> </tr> <tr> <td>Preparation of the seminar presentation</td> <td>30 h</td> </tr> <tr> <td>Preparation for the final exam</td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </tbody> </table>	Lecture: 15 × 3 h	45 h	Seminar: 15 × 1 h	15 h	Preparation and recapitulation (lecture + seminar): 15 × 4 h	60 h	Preparation of the seminar presentation	30 h	Preparation for the final exam	<u>30 h</u>		180 h
Lecture: 15 × 3 h	45 h												
Seminar: 15 × 1 h	15 h												
Preparation and recapitulation (lecture + seminar): 15 × 4 h	60 h												
Preparation of the seminar presentation	30 h												
Preparation for the final exam	<u>30 h</u>												
	180 h												
<b>Examination and unit completion</b>	seminar presentation, final exam												
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience												
<b>Language</b>	English (German on request)												
<b>Time slot and frequency</b>	Winter term												

## **Organometallic Chemistry of the Main Group Elements – Lab Course**

### **Study Programme**

Master Chemistry (IC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** Typically four weeks (flexible start date)

**Module grade** Based on (i) the experimental work, (ii) the written report, and (iii) presentations of the results in the group meeting

**Lecturer** Prof. Dr. A. Lorbach

**Educational objectives** Safe handling, synthesis and characterization of organometallic compounds during an internship in the research group

**Teaching content** The lab course allows the participants to gain deeper insight into organometallic main group chemistry and particularly organoboron chemistry. By working under the supervision of an experienced PhD candidate, the students get hands-on training in preparing and handling sensitive compounds under inert conditions. The lab course can also include optical or electronic characterization methods.

**Forms of teaching/  
Amount of SWS** Practical internship, typically four weeks

**Work load** Practical internship (including preparation of a report) 180 h

**Examination and unit completion** Written lab report after completion of the lab course

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English (German on request)

**Time slot and frequency** Time slots are assigned individually upon request

<b>Organometallics in Organic Syntheses – Lecture</b>													
<b>Study Programme</b> Master Chemistry (OC), Master Life Science, Master Nanoscience													
<b>Credits</b>	6 ECTS												
<b>Duration</b>	1 Semester												
<b>Module grade</b>	Based on seminar presentation (30%) and oral/written examination (70%)												
<b>Lecturer</b>	Dr. T. Huhn												
<b>Educational objectives</b>	Comprehensive knowledge of handling, preparation and use of organometallic reagents in the context of organic synthesis.												
<b>Teaching content</b>	<p>Organometallics are widely used as catalyst-systems or reagents in modern synthesis of molecules and materials.</p> <p>The lecture will give an overview on preparation/ <i>in situ</i> preparation of main group and transition metal organometallics and their use in synthesis. Besides their properties and reactivities their application in the formation of C–C and C–(O,N,S) bonds, CH-activation, directed metalations, as well as metal promoted cycloaddition reactions and Carbometalations will be discussed.</p> <p>In the seminar the participants present recent publications from the research field and critically discuss the results and conclusions.</p>												
<b>Forms of teaching/ Amount of SWS</b>	Lecture 2 SWS, seminar 2 SWS												
<b>Work load</b>	<table> <tbody> <tr> <td>Lecture: 15 weeks x 2 SWS</td> <td>30 h</td> </tr> <tr> <td>Seminar: 15 weeks x 2 SWS</td> <td>30 h</td> </tr> <tr> <td>Self-study</td> <td>60 h</td> </tr> <tr> <td>Preparation of presentation</td> <td>30 h</td> </tr> <tr> <td>Preparation for final exam</td> <td>30 h</td> </tr> <tr> <td></td> <td><math>\Sigma</math> 180h</td> </tr> </tbody> </table>	Lecture: 15 weeks x 2 SWS	30 h	Seminar: 15 weeks x 2 SWS	30 h	Self-study	60 h	Preparation of presentation	30 h	Preparation for final exam	30 h		$\Sigma$ 180h
Lecture: 15 weeks x 2 SWS	30 h												
Seminar: 15 weeks x 2 SWS	30 h												
Self-study	60 h												
Preparation of presentation	30 h												
Preparation for final exam	30 h												
	$\Sigma$ 180h												
<b>Examination and unit completion</b>	Final examination (80%) and presentation (20%)												
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience												
<b>Language</b>	English (German on request)												
<b>Time slot and frequency</b>	Winter term												

## **Organometallics in Organic Syntheses – Lab course**

### **Study Programme**

Master Chemistry (OC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS
<b>Duration</b>	1 Semester
<b>Module grade</b>	Based in equal parts on internship and written report
<b>Lecturer</b>	Dr. T. Huhn
<b>Educational objectives</b>	Synthesis and use of organometallic compounds during an internship in the research group
<b>Teaching content</b>	During the research internship the participants will take part in the ongoing research project of a PhD-student in the field of modern organic synthesis. This allows the participants deeper insights into the topic of applied organometallic chemistry.
<b>Forms of teaching/ Amount of SWS</b>	Internship
<b>Work load</b>	Internship and written report <span style="float: right;">180 h</span>
<b>Examination and unit completion</b>	Internship (50%), written report (50%)
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	According to the agreement

<b>Polycyclic Natural Products and their Total Synthesis – Lecture</b>											
<b>Study Programme</b> Master Chemistry (OC), Master Life Science, Master Nanoscience											
<b>Credits</b>	6 ECTS										
<b>Duration</b>	1 Semester										
<b>Module grade</b>	The grade of this module is the grade of the written exam.										
<b>Lecturer</b>	Prof. Dr. T. Gaich										
<b>Educational objectives</b>	In-depth-knowledge in synthetic planning; strategy and retrosynthetic planning. Application of these concepts to complex natural products. Understanding of reaction mechanisms, and their application to multi-step synthesis.										
<b>Teaching content</b>	Natural product synthesis is very often the starting point for drug development in pharmaceutical industry for "lead-structure" development. The syllabus contains: Synthetic planning of complex molecule synthesis; Application of new reactions to total synthesis; fundamental understanding of regio-stereo-and chemoselectivity; the reactivity/selectivity principle and mechanistic understanding of complex processes.										
<b>Forms of teaching/ Amount of SWS</b>	Lecture 2 SWS, Seminar 2 SWS										
<b>Work load</b>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%;">Lecture: 15 weeks x 2 SWS</td> <td style="text-align: right;">30 h</td> </tr> <tr> <td>Seminar: 15 weeks x 2 SWS</td> <td style="text-align: right;">30 h</td> </tr> <tr> <td>Preparation 1.5 h/lectured hour.:</td> <td style="text-align: right;">90 h</td> </tr> <tr> <td><u>Preparation for written examination</u></td> <td style="text-align: right;"><u>30 h</u></td> </tr> <tr> <td></td> <td style="text-align: right;"><math>\Sigma</math> 180 h</td> </tr> </table>	Lecture: 15 weeks x 2 SWS	30 h	Seminar: 15 weeks x 2 SWS	30 h	Preparation 1.5 h/lectured hour.:	90 h	<u>Preparation for written examination</u>	<u>30 h</u>		$\Sigma$ 180 h
Lecture: 15 weeks x 2 SWS	30 h										
Seminar: 15 weeks x 2 SWS	30 h										
Preparation 1.5 h/lectured hour.:	90 h										
<u>Preparation for written examination</u>	<u>30 h</u>										
	$\Sigma$ 180 h										
	In the 6-Credit-Variant the laboratory part is omitted.										
<b>Examination and unit completion</b>	Written exam										
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience										
<b>Language</b>	English (German on request)										
<b>Time slot and frequency</b>	Summer term										

## Polycyclic Natural Products and their Total Synthesis – Lab Course

### Study Programme

Master Chemistry (OC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The grade of this module is the grade of the written report on the experimental work.

**Lecturer** Prof. Dr. T. Gaich

**Educational objectives** Practical experience in multi-step synthesis, synthetic planning of multi-step synthetic sequences including retrosynthetic planning. Investigation and probing of reaction mechanisms. Detailed NMR spectroscopic analysis of synthetic intermediates.

**Teaching content** Natural product synthesis is very often the starting point for drug development in pharmaceutical industry for "lead-structure" development. The students will participate in the synthesis of a natural product or drug currently under investigation in the group. The student will learn state-of-the art synthetic techniques and synthetic methodology, analyse synthetic intermediates and participate in synthetic planning.

**Forms of teaching/  
Amount of SWS** Practical laboratory course in the group laboratories, supervised (one-on-one) by a PhD or PostDoc of the group 6 SWS

<b>Work load</b>	Practical work in the lab (4 weeks)	140 h
	includes participation to the group seminar (every WED 8:15-11h L829)	
	Preparation of report/protocol	40 h
		Σ 180 h

In the 6-Credit-Variant the laboratory part is omitted.

**Examination and unit completion** Grading of experimental work (purity and yields of compounds synthesized) and protocol/report written in English

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English (German on request)

**Time slot and frequency** According to the agreement

<b>Synthesis and Properties of Functional Materials – Lecture</b>									
<b>Study Programme</b> Master Chemistry (AC), Master Life Science, Master Nanoscience									
<b>Credits</b>	6 ECTS								
<b>Duration</b>	1 Semester								
<b>Module grade</b>	The overall score of this course is the grade of the colloquium on the subject matter of the lecture								
<b>Lecturer</b>	Prof. Dr. S. Mecking								
<b>Educational objectives</b>	The participants gain an in-depth understanding and knowledge of topical methods and problems in the preparation of functional materials, and their structure and properties.								
<b>Teaching content</b>	Controlled metal-mediated polymerization to different molecular architectures and morphologies: living chain growth, reversible transmetallation to multiblock copolymers, ring opening, redox-strategies, radical growth. Synthesis of conjugated semiconducting polymers and optical properties, OLEDs and polymer solar cells. Inorganic Polymers. Preparation and characterization of nanoparticles, nanocomposites, and coatings.								
<b>Forms of teaching/ Amount of SWS</b>	Lecture + tutorial 4 SWS (3V/1Ü)								
<b>Work load</b>	<table> <tr> <td>Lecture + tutorial: 15 weeks x 4 SWS</td> <td>60 h</td> </tr> <tr> <td>Preparation and wrap-up 1.5h/contact hour</td> <td>90 h</td> </tr> <tr> <td>Preparation of the final exam</td> <td><u>30 h</u></td> </tr> <tr> <td></td> <td>180 h</td> </tr> </table>	Lecture + tutorial: 15 weeks x 4 SWS	60 h	Preparation and wrap-up 1.5h/contact hour	90 h	Preparation of the final exam	<u>30 h</u>		180 h
Lecture + tutorial: 15 weeks x 4 SWS	60 h								
Preparation and wrap-up 1.5h/contact hour	90 h								
Preparation of the final exam	<u>30 h</u>								
	180 h								
<b>Examination and unit completion</b>	Ca. 45 min. exam on the subject matter of the lecture.								
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience								
<b>Language</b>	English (German on request)								
<b>Time slot and frequency</b>	Winter and summer term								

## **Synthesis and Properties of Functional Materials – Lab course**

### **Study Programme**

Master Chemistry (AC), Master Life Science, Master Nanoscience

**Credits** 6 ECTS

**Duration** 1 Semester

**Module grade** The module grade is based on the written report and the laboratory work

**Lecturer** Prof. Dr. S. Mecking

**Educational objectives** The participants gain an in-depth understanding and knowledge of topical methods and problems in the preparation of functional materials, and their structure and properties.

**Teaching content** Controlled metal-mediated polymerization to different molecular architectures and morphologies: living chain growth, reversible transmetalation to multiblock copolymers, ring opening, redox-strategies, radical growth. Synthesis of conjugated semiconducting polymers and optical properties, OLEDs and polymer solar cells. Inorganic Polymers. Preparation and characterization of nanoparticles, nanocomposites, and coatings.

**Forms of teaching/  
Amount of SWS** Practical course in the form of participation in a research project

**Work load** Practical course inkl. written report and oral presentation: 180 h

**Examination and unit completion** The report is due within three months of the completion of the laboratory work.

**Prerequisites** Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience

**Language** English (German on request)

**Time slot and frequency** Summer and winter term, according to individual agreement

## Synthesis of natural products and drugs – Lecture

### Study Programme

Master Chemistry (OC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS	
<b>Duration</b>	1 Semester	
<b>Module grade</b>	The module grade is the grade of the written exam.	
<b>Lecturer</b>	Prof. Dr. T. Gaich	
<b>Educational objectives</b>	In-depth-knowledge in synthetic planning; strategy and retrosynthetic planning. Application of these concepts to complex natural products. Understanding of reaction mechanisms, and their application to multi-step synthesis.	
<b>Teaching content</b>	<p>Natural product synthesis is very often the starting point for drug development in pharmaceutical industry for "lead-structure" development.</p> <p>The syllabus contains: Synthetic planning of complex molecule synthesis; application of new reactions to total synthesis; fundamental understanding of regio-stereo-and chemoselectivity; the reactivity/selectivity principle and mechanistic understanding of complex processes.</p>	
<b>Forms of teaching/ Amount of SWS</b>	Lecture 2 SWS, seminar 2 SWS	
<b>Work load</b>	Lecture: 15 weeks x 2 SWS	30 h
	Seminar: 15 weeks x 2 SWS	30 h
	Preparation 1.5 h/lectured hour.:	90 h
	Preparation for written examination	30 h
		Σ 180 h
	In the 6-Credit-Variant the laboratory part is omitted.	
<b>Examination and unit completion</b>	Written exam	
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience	
<b>Language</b>	English (German on request)	
<b>Time slot and frequency</b>	Summer term	

## Synthesis of natural products and drugs – Lab Course

### Study Programme

Master Chemistry (OC), Master Life Science, Master Nanoscience

<b>Credits</b>	6 ECTS								
<b>Duration</b>	1 Semester								
<b>Module grade</b>	The grade of this module is the grade of the written report on the experimental work.								
<b>Lecturer</b>	Prof. Dr. T. Gaich								
<b>Educational objectives</b>	Practical experience in multi-step synthesis, synthetic planning of multi-step synthetic sequences including retrosynthetic planning. Investigation and probing of reaction mechanisms. Detailed NMR spectroscopic analysis of synthetic intermediates.								
<b>Teaching content</b>	Natural product synthesis is very often the starting point for drug development in pharmaceutical industry for "lead-structure" development. The students will participate in the synthesis of a natural product or drug currently under investigation in the group. The students will learn state-of-the art synthetic techniques and synthetic methodology, will analyse synthetic intermediates and participate in synthetic planning.								
<b>Forms of teaching/ Amount of SWS</b>	Practical laboratory course in the group laboratories, supervised (one-on-one) by a PhD or PostDoc of the group 6 SWS								
<b>Work load</b>	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">Practical work in the lab (4 weeks)</td> <td style="text-align: right;">140 h</td> </tr> <tr> <td>includes participation to the group seminar (every WED 8:15-11h L829)</td> <td></td> </tr> <tr> <td><u>Preparation of report/protocol</u></td> <td style="text-align: right;"><u>40 h</u></td> </tr> <tr> <td></td> <td style="text-align: right;"><math>\Sigma</math> 180 h</td> </tr> </table> <p>In the 6-Credit-Variant the laboratory part is omitted.</p>	Practical work in the lab (4 weeks)	140 h	includes participation to the group seminar (every WED 8:15-11h L829)		<u>Preparation of report/protocol</u>	<u>40 h</u>		$\Sigma$ 180 h
Practical work in the lab (4 weeks)	140 h								
includes participation to the group seminar (every WED 8:15-11h L829)									
<u>Preparation of report/protocol</u>	<u>40 h</u>								
	$\Sigma$ 180 h								
<b>Examination and unit completion</b>	Grading of experimental work (purity and yields of compounds synthesized) and protocol/report written in English								
<b>Prerequisites</b>	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience								
<b>Language</b>	English (German on request)								
<b>Time slot and frequency</b>	According to the agreement								

<b>Oral master's examination</b>	
<b>Study programme</b> Master in Chemistry, Master in Life Science, Master in Nanoscience	
<b>Credits</b>	15 ECTS credits
<b>Duration</b>	1 semester
<b>Module grades</b>	For each of the three oral master's examinations, the grades are calculated as the average from the grades of the two examiners. The oral examinations for the subject of specialization and the 2nd and 3rd major are weighted 3:2:2 in the overall grade. Additional information by the lecturer.
<b>Lecturers</b>	University teachers from the Department of Chemistry
<b>Educational objectives</b>	In-depth knowledge in the three majors: Inorganic Chemistry, Organic Chemistry and Physical Chemistry. In addition to subject-related knowledge and special methodological knowledge, the students will also learn how to recognize overarching correlations, how to think in general terms and how to express things in correct expert language.
<b>Teaching content</b>	The oral master's examinations cover the majors: Inorganic Chemistry, Organic Chemistry and Physical Chemistry. Meetings will take place with the university teachers responsible for these subjects. The teachers will recommend literature for in-depth self-study, answer the student's questions and recommend the participation in select guest lectures at the Department of Chemistry.
<b>Forms of teaching/ Amount of SWS</b>	Self-study, meeting with university teachers, participation in guest lectures
<b>Work load</b>	450 hours
<b>Examination and unit completion</b>	Three oral examinations, each conducted by two examiners. One of these examinations lasts around 60 minutes and covers the area of specialization. The other two last around 30 minutes each and will be held right after each other. They cover the 2nd and 3rd major; recommended semester: 3rd semester
<b>Prerequisites</b>	All course-related performance assessments stated in the study and examination regulations must have been completed
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	Winter and summer semester

<b>Master's thesis</b>	
<b>Study programme</b> Master Chemistry, Master Life Science, Master Nanoscience	
<b>Credits</b>	30 ECTS
<b>Duration</b>	6 months
<b>Module grade</b>	The grade for the master's thesis is calculated as the average from the grades determined by the two reviewers.
<b>Lecturers</b>	University teachers from the Department of Chemistry
<b>Educational objectives</b>	Students shall be able to scientifically work on a topic from the field of chemistry themselves by conducting experiments in a defined period of time and documenting their findings in the form of a written thesis.
<b>Teaching content</b>	Independently compiling a plan for writing the master's thesis, independently acquiring knowledge of the current expert literature, determining the methods required to carry out the experiments in the lab, independently evaluating the experiments and discussing the results, writing the master's thesis
<b>Forms of teaching/ Amount of SWS</b>	All-day instruction on scientifically working in a team
<b>Work load</b>	900 hours
<b>Examination and unit completion</b>	Writing of the master's thesis; recommended semester: 3rd-4th semester
<b>Prerequisites</b>	1. All course-related performance assessments stated in the study and examination regulations must have been completed 2. Final oral examination must have been passed
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	Winter and summer semester

<b>Master's colloquium</b>	
<b>Study Programme</b> Master Chemistry, Master Life Science, Master Nanoscience	
<b>Credits</b>	15 ECTS credits
<b>Duration</b>	2 semesters
<b>Module grades</b>	This module is not graded
<b>Lecturers</b>	University teachers from the Department of Chemistry
<b>Educational objectives</b>	The students shall be able to present the findings from their master's thesis in a public colloquium/thesis defence, put these findings in a scientific context and discuss them accordingly. In addition to this, they should be able to participate in the scientific discussions at the colloquia held by other students of the Master's Programme Chemistry.
<b>Teaching content</b>	Current fields of chemistry research at the University of Konstanz. Independently compiling suitable slides to present the findings of the master's thesis. Presentation of the findings in a scientific talk. Independently acquiring knowledge of the current expert literature, both on the topic of their own master's thesis as well as those of other students of the Master's Programme Chemistry. Participation in the final oral examination of other students of the Master's Programme Chemistry as well as participation in the scientific discussion.
<b>Forms of teaching/ Amount of SWS</b>	Self-study and participation in colloquia
<b>Work load</b>	150 hours preparing for the presentation of the master's thesis, 40 hours presence in colloquia/thesis defences, 260 hours preparing and following-up the colloquia totalling 450 hours
<b>Examination and unit completion</b>	Recommended semester: 3rd - 4th semester
<b>Prerequisites</b>	
<b>Language</b>	English (German on request)
<b>Time slot and frequency</b>	Winter and summer semester