Universität Konstanz

Master Programmes

Chemistry
Life Science
Nanoscience

Module guide - September 2022

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Content

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 Element Organic Chemistry – Lecture

Study Programme
Master Chemistry (AC), 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. M. Unterlass, Prof. Dr. R. Winter
Educational objectives	The students will obtain deeper insight into the field of main group and transition metal chemistry with particular emphasis on the synthesis, properties and structural aspects (especially structure-reactivity relationships) of metal-organic reagents of the main group elements and the relation between them. They will also gain an understanding of the synthesis, electronic and magnetic properties of sandwich, half-sandwich and bent-metallocene complexes of the transition metals with carbo- and heterocyclic ligands and their widespread applications.
Teaching content	Synthesis, properties, applications and utilization of homo- and heteroleptic sandwich complexes of the main group and transition metal elements with carbocyclic and heterocyclic rings as ligands, of bent-metallocenes and of half-sandwich piano-stool complexes. Synthesis, structural chemistry, crystallography, and reactivities of main group organyls and alkoxydes, metal and element organic frameworks, and zeolites.
Forms of teaching/ Amount of SWS	Lecture 4 SWS
Work load	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, 2 h
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience
Language	English (German on request)
Time slot and frequency	Winter term

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
Work load	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

Advanced Organic 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.
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 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.
Teaching content	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.
Forms of teaching/ Amount of SWS	Research internship
Work load	Lab work 160 h Written report 20 h 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.

Advanced Solid State Chemistry – Lecture

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	6 ECTS
Duration	1 Semester
Module grade	The final grade is the grade for the oral exam.
Lecturer	Prof. Dr. Miriam Unterlass
Educational objectives	Understanding state-of-the-art vs. beyond state-of-the-art current developments in solid state and materials chemistry; Finding, reading, and excerption of information from scientific publications; In-depth understanding of structure-property-application relationships in advanced solids beyond the disciplinary context of organic vs. inorganic solids.
Teaching content	Latest developments in solid state chemistry both with respect to basic and applied research aspects. Each covered topic will be introduced (definitions, context, recap of basics) and subsequently dealt with in depth through reading and discussion of scientific articles on the topic. Covered topics vary ever year to some extent, as a function of the latest developments in solid state and materials chemistry. Covered topics include, but are not limited to: High-entropy alloys; Frameworks; Hybrid materials, Rapid prototyping & additive manufacturing; Automated materials discovery, synthesis, and testing; etc.
Forms of teaching/ Amount of SWS	Lecture 4 SWS
Work load	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	Oral exam
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience
Language	English
Time slot and frequency	Summer term

Advanced Solid State Chemistry – Lab course

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	6 ECTS
Duration	4 weeks (full-time)
Module grade	The grade is calculated from lab work (practical + lab journal) and the written report
Educational objectives	Hands-on synthesis and characterization of functional solids; Ability to grasp the state-of-the-art of the assigned research topic through literature search and contextualizing the literature; Refinement of synthetic protocols towards a desired solid; Understanding of the need for solid-state characterizations; their peculiarities, and their differences to characterizations in solution; Presentation and discussion of solid-state characterization data
Teaching content	The participants of this lab course will be assigned the synthesis of a type functional solid, specifically a series of solids (e.g., different degrees of functionality, such as: porosity, crystallinity, particle size, particle shape) of that type. These different degrees of functionality will be attained through variations of the synthetic protocols. The materials will be characterized by a combination of solid-state techniques, e.g., FT-IR spectroscopy, solid-state NMR spectroscopy, solid-state UV-Vis and fluorescence spectroscopy, powder X-ray diffraction, single crystal X-ray diffraction, Small angle X-ray scattering; gas sorption; optical, scanning electron, and transmission electron microscopy. Through the materials characterization data obtained, the students will evaluate the effects of the synthetic variations on obtaining the desired degrees of functionality in the target solids.
Forms of teaching/ Amount of SWS	Research internship
Work load	Lab work 160 h Written report 20 h 180 h
Examination and unit completion	Lab work, written report
Language	English
Time slot and frequency	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 Preparation 2h/contact hour	15 h 30 h 180 h
Examination and unit completion	Graded exercise sheets and/or short tests	
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience	
Language	English (German on request)	
Time slot and frequency	Winter term	

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

Biocatalysis – Enzyme Discovery, Mechanism, Engineering – Lecture

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

Credits	3 ECTS
Duration	1 Semester
Module grade	The final grade is the grade for the exam.
Lecturer	Tenure-Track-Prof. Dr. Lena Barra
Educational objectives	Enzymes are the ubiquitous key players in all metabolic pathways and catalyze remarkable chemical transformations, especially in secondary metabolite biosynthetic pathways. The implementation of their catalytic versatility into organic synthetic and biotechnological applications has become an important research field, both in academia and the chemical and pharmaceutical industries, since enzyme-based technologies benefit from their inherent biocompatibility and allow for green access to pharmaceuticals and fine chemicals. The training course will teach modern aspects of biocatalysis with a focus on enzyme discovery, mechanism, and applications.
Teaching content	The first part of the lecture will give an introduction into basic methods and concepts of enzymology and biocatalysis (enzyme properties and structure, classification and nomenclature, general mechanisms and kinetic aspects, chemistry of enzyme cofactors), followed by an in-depth discussion of important enzyme families and their catalytic versatility (polyketide synthases, non-ribosomal peptide synthetases, terpene synthases, PLP-dependent enzymes, tailoring enzymes). Recent examples for their biocatalytic application in organic synthesis and synthetic biology will be highlighted. The last part will focus on teaching state-of-the-art techniques revolving around the questions: how to find novel enzymes (enzyme databases and bioinformatic tools for genome-mining), how to predict and analyze their structure and functions (phylogenetics, structural biology and modelling, sequence similarity networks), and how to engineer desired enzyme functions (directed evolution and rational design).
Forms of teaching/ Amount of SWS	Lecture 2 SWS
Work load	Lectures 15 weeks x 2 SWS — 30 h Self-study 1 h / h lectures — 45 h Preparation for examination — 15 h 90 h
Examination and unit completion	Final exam covering the topics presented in the lectures
Prerequisites	Bachelor Chemistry or Bachelor Life Science or Bachelor Nanoscience
Language	English (German on request)
Time slot and frequency	Winter term

Biocatalysis – Enzyme Discovery, Mechanism, Engineering – Lab course

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

Credits	6 ECTS
Duration	4 weeks (full time)
Module grade	Grade of practical work performance and written lab report
Lecturer	Tenure-Track-Prof. Dr. Lena Barra
Educational objectives	Enzymes are the ubiquitous key players in all metabolic pathways and catalyze remarkable chemical transformations, especially in secondary metabolite biosynthetic pathways. The implementation of their catalytic versatility into organic synthetic and biotechnological applications has become an important research field, both in academia and the chemical and pharmaceutical industries, since enzyme-based technologies benefit from their inherent biocompatibility and allow for green access to pharmaceuticals and fine chemicals. The training course will teach modern aspects of biocatalysis with a focus on enzyme discovery, mechanism, and applications.
Teaching content	The lab course will teach practical methods in biocatalysis (e.g. bioinformatic analysis and mining of genomic data, enzyme target identification, enzyme expression and purification, functional assignment, synthetic applications) in the context of on-going research topics conducted in the workgroup.
Forms of teaching/ Amount of SWS	Practical training by participation in current research projects.
Work load	Lab work 160 h Written report 20 h 180 h
Examination and unit completion	Successful participation in the practical training documented by a written lab report
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	According to the agreement

Biophysical 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	Dr. Guinevere Mathies, Prof. Dr. K. Hauser
Educational objectives	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.
Teaching content	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. 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 Part II (Thermodynamics & 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
Forms of teaching/ Amount of SWS	Lecture 2 SWS, exercise 2 SWS
Work load	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 — 60 h 180 h
Examination and unit completion	Oral exam (30 minutes)
Prerequisites	Bachelor Chemistry or Bachelor Life Science or Bachelor Nanoscience
Language	English
Time slot and frequency	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
Work load	Lab work 160 h Written report 10 h Preparation of the colloquium 10 h 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.

Biopolymer 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. A. Marx, Prof. Dr. V. Wittmann
Educational objectives	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.
Teaching content	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.
Forms of teaching/ Amount of SWS	Lectures 3h/week, Seminar 1 h/week
Work load	Lectures: 15 weeks × 3 h/week 45 h Seminar: 15 weeks x 1 h/week 15 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	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
Work load	Lab work 160 h Written report 20 h 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.

Breakthroughs in natural sciences exemplified by granted Nobel prizes – Lecture

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience, Master Biological Sciences, Master Physical Sciences

Credits	3 ECTS
Duration	1 Semester
Module grade	Module grade corresponds to seminar presentation.
Lecturer	Prof. Dr. Michael Kovermann
Educational objectives	This course focuses on Nobel prizes awarded in Chemistry, Physiology or Medicine and Physics. The successful participation will enable the students to expand the horizons while ranking individual scientific contributions into a broader context.
Teaching content	This course illuminates the science behind the Nobel prizes that have been granted in Chemistry, Physiology or Medicine and Physics that have, in particular, strong ties to the ongoing research conducted at Konstanz University. One focus lies in the presentation and explanation of phenomena which resulted in the justification for awarding the Nobel prize. Another aspect lies in the research that have followed and built up on the basic findings.
Forms of teaching/ Amount of SWS	Lecture 1.5 h/week, Seminar 0.5 h/week
Work load	Lectures: 15 weeks × 1.5 h/week 22.5 h Seminar: 15 weeks x 0.5 h/week 7.5 h Preparation (L + S): 15 weeks 2 h/week 30.0 h Preparation presentation 30.0 h 90.0 h
Examination and unit completion	Presentation 30 min.
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience / Bachelor Physical Sciences / Bachelor Biological Sciences
Language	English (German on request)
Time slot and frequency	Winter term

Colloidal Metal and Metal-Based Nanomaterials – Lecture

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

Credits	6 ECTS
Duration	1 Semester
Module grade	The module grade is based on the oral exam and seminar talk.
Lecturer	Dr. G. González-Rubio
Educational objectives	This course covers the most relevant aspects of colloidal metal and metal-based NPs, ranging from synthesis and self-assembly to catalysis and medicine applications.
Teaching content	• Synthesis: colloidal synthesis methods, growth modes and patterns, thermodynamic and kinetic control, seed-mediated growth, crystal defects, core-shell, alloy, intermetallic, galvanic replacement reactions, Kirkendall effects, chirality in inorganic nanomaterials, surface ligand role, ultrafast pulsed laser for synthesis and post-synthesis modification. • Self-assembly techniques to create complex materials with novel functionalities: attractive and repulsive interactions, hierarchical assemblies, self-assembly at interphases, directed and stimuli-responsive self-assembly, supraparticles and supercrystals. • Application in catalysis and medicine: hydrogen production, carbon dioxide reduction, carbon monoxide oxidation, fuel-cells, synthesis of ammonia, photothermal therapy, cancer treatment, drug delivery, imaging and sensing.
Forms of teaching/ Amount of SWS	Lecture (4 SWS) and seminar (2 SWS)
Work load	Lecture: 15 Weeks x 4 SWS — 60 h Preparation and follow-up: 1h per contact hour — 60 h Seminar — 30 h Preparation for oral examination — 30 h 180h
Examination and unit completion	Seminar presentation and 20 minutes of oral examination
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience
Language	English (German on request)
Time slot and frequency	Summer term

Colloidal Metal and Metal-Based Nanomaterials – Lab course

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

Credits	6 ECTS
Duration	1 Semester
Module grade	The module grade is composed of the grade for the practical work (50 %) and the grade for the written or oral report (50%).
Lecturer	Prof. Dr. Helmut Cölfen and Dr. G. González-Rubio
Educational objectives	Synthesis, assembly and characterisation of metal and metal-based nanoparticles.
Teaching content	• Synthesis and assembly of colloidal metal and metal-based nanomaterials: size-dependent properties, synthesis of nanoparticles and size/shape/heterostructure control, separation of nucleation and growth, surface functionalisation, stability and aggregation, self-assembly. • Characterisation: analytical ultracentrifugation, dynamic light scattering, transmission and scanning electron microscopy, XRD-diffraction, and energy dispersive, UV-Vis-NIR, fluorescence, circular dichroism and infrared spectroscopies.
Forms of teaching/ Amount of SWS	Practical lab training
Work load	Practical lab training including report or oral presentation 180h
Examination and unit completion	Report of the lab training resp. oral presentation (50 %) and performance in the laboratory (50 %)
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	According to the agreement

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 (themostats, 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; …)
Forms of teaching/ Amount of SWS	Lecture 2 SWS, Computer exercises 2 SWS
Work load	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 collloquium — 30 h 180 h
Examination and unit completion	Oral exam
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience
Language	English (German on request)
Time slot and frequency	Summer term

Computational 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 oral project presentation and the documentation of the results.
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.
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 (themostats, 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; matlab; …)
Forms of teaching/ Amount of SWS	Research Practical
Work load	Research practical: 180 h
Examination and unit completion	Oral presentation of the research practical period / documentation of results
Prerequisites	Computational chemistry course
Language	English (German on request)
Time slot and frequency	Personal communication

Current Issues and Methods in Nanoscience – Lecture

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	6 ECTS
Duration	1 Semester
Module grade	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.
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	The lecture addresses the following topics: • Basics and properties of Fourier transformation • Band structure of solids, **k** · **p** theory • Plasmonics of metal nanoparticles, shape/function relationship • Carbon nanostructures, effects of low dimensionality • Semiconductor nanocrystals, size quantisation effect • Excitons, time-resolved optical spectroscopy, spectroelectrochemistry • Heterostructures, heterointerfaces, surface effects • Fluorescence quantum yield, fluorescence intermittency • Quantum dot lasers, charge carrier multiplication • Ion exchange, Doping of nanocrystals, MCD spectroscopy • Nanocrystal-based sensors, interaction between nanoparticles • Magnetic nanoparticles, magnetism on the nanoscale
Forms of teaching/ Amount of SWS	6 ECTS: Lecture (3 SWS), Seminar (1 SWS)
Work load	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 — 30 h 180 h
Examination and unit completion	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. 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.
Prerequisites	Bachelor Chemistry / Bachelor Life Science / Bachelor Nanoscience
Language	English (German on request)
Time slot and frequency	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 re-quired to finish this module.
Language	English or German
Time slot and frequency	According to the agreement

Dispersion Colloids in Research and Industry – Lecture

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

Credits	6 ECTS
Duration	1 Semester
Module grade	Final grade is calculated as follows: lecture 2/3, seminar presentation 1/3
Lecturer	Prof. Dr. A. Wittemann
Educational objectives	The students acquire knowledge on dispersion colloids and their applications in science and technology.
Teaching content	General classification of colloids & dispersion, particularly with regard to sus-pensions and emulsions: - Macroemulsions, miniemulsions and microemulsions (preparation of emulsions by various methods, emulsion stability and stabilization mechanisms, role of emulsifiers, theoretical concepts) - Synthesis of polymer dispersions (emulsion polymerization, dispersion polymerization, miniemulsion polymerization, *etc.*) from the lab to the industrial scale - Practical applications of polymer dispersions - Colloidal stability and appropriate ways to stabilize dispersed systems are of central importance.
Forms of teaching/ Amount of SWS	Lecture 3 SWS, seminar 1 SWS
Work load	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 — 30 h 160 h
Examination and unit completion	Oral presentation (25 min) on a current topic of colloid science, final colloquium (40 min)
Prerequisites	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.
Language	English (German on request)
Time slot and frequency	Winter term

Dispersion Colloids in Research and Industry – Lab course

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

Credits	6 ECTS
Duration	1 Semester
Module grade	Final grade is calculated as follows: practical performance 1/3, oral presentation 1/3, written report 1/3
Lecturer	Prof. Dr. A. Wittemann
Educational objectives	The students get involved in an ongoing research project related to colloid science.
Teaching content	Active involvement in an advanced research project in colloid science will help to train practical research skills.
Forms of teaching/ Amount of SWS	Practical lab work by participation in a current research project Block course of 160 h – dates by arrangement
Work load	Lab course 160 h Preparation of the lab course 5 h Preparation of the oral presentation 15 h Written report 20 h 200 h
Examination and unit completion	Oral presentation of the lab project (20 min), evaluation of the practical performance and the final report
Prerequisites	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
Language	English (German on request)
Time slot and frequency	According to the agreement

Gene Expression and Replication – Lecture

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	6 ECTS
Duration	1 Semester
Module grade	The grade reflects the result of the written exam.
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 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.
Forms of teaching/ Amount of SWS	Lectures 3 SWS, Seminar 2 SWS
Work load	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 30 h 180 h
Examination and unit completion	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.
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English
Time slot and frequency	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

High-resolution NMR spectroscopy directed to biological and biophysical applications – Lecture

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	Lecture 3 SWS, Seminar 1 SWS
Work load	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 — 30 h 180 h
Examination and unit completion	Presentation 30 min. and final colloquium 30 min. (equally weighted)
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	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 objecti-ves	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-resolu-tion 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, para-magnetic 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

Industrial Chemistry and Renewable Resources – Lecture

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	6 ECTS
Duration	1 Semester
Module grade	The overall score of this course is the grade of the colloqium (75 %) on the subject matter of the lecture and of the seminar presentation (25 %)
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 petrochemcial 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	Lecture, Seminar and Excursion. 4SWS
Work load	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 180 h
	Ca. 45 min exam on the subject matter of the lecture; seminar presentation.
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	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 petrochemcial 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

Metal-Organic Chemistry and Catalysis – Lecture

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

Credits	6 ECTS
Duration	1 Semester
Module grade	Grade of the final examination (oral or written exam)
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 and their steric and electronic properties • Alkyl- and -aryl complexes: Synthesis, stabilities, decomposition pathways, Pd- and Ni-catalyzed C-C cross coupling reactions and their 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	Lecture
Work load	Lecture + seminar: 15 weeks × 5 SWS — 75 SWS Preparation / Learning: 1 h per contact hour — 75 SWS Preparation for examination — 30 SWS
Examination and unit completion	Oral exam of ca. 45 min or 2h written exam
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	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

Molecular Spectroscopy – Lecture

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

Credits	6 ECTS
Duration	1 Semester
Module grade	Oral exam
Lecturer	Prof. Dr. K. Hauser, Prof. Dr. Malte Drescher, Prof. Dr. A. Zumbusch
Educational objectives	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.
Teaching content	Contents of the lecture (6-ECTS variant): • classical description of the interaction between electromagnetic radiation and matter: Einstein coefficients, refractive index, line shapes, lifetimes, polarisability, Raman scattering • incoherent spectroscopy: time-dependent perturbation theory of spectroscopic transitions, transition dipole moment, absorption and fluorescence spectroscopy, infrared-spectroscopy • coherent spectroscopy: density representations in quantum mechanics, density matrix formalism, two-level system in ultrafast optical spectroscopy and magnetic resonance spectroscopy (NMR and EPR) • depending on the previous knowledge of the students, the course will give brief introductions into Fourier transformations, description of waves, and matrix calculus
Forms of teaching/ Amount of SWS	Lecture 4 SWS
Work load	Lecture: 15 weeks x 4 SWS: 60 h Preparation and post-processing (1.5 h/contact hour): 90 h Final exam preparation: 30 h 180 h
Examination and unit completion	Oral exam (30 minutes)
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience / Recommended: Master course „Advanced Physical Chemistry“
Language	English (German on request)
Time slot and frequency	Summer term

Molecular Spectroscopy – Lab course

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

Credits	6 ECTS
Duration	1 Semester
Module grade	Seminar talk
Lecturer	Prof. Dr. K. Hauser, Prof. Dr. Malte Drescher, Prof. Dr. A. 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 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
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience / Recommended: Master course „Advanced Physical Chemistry"
Language	English (German on request)
Time slot and frequency	According to the agreement

Nanochemistry and -analytics – Lecture

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

Credits	6 ECTS
Duration	1 Semester
Module grade	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.
Lecturer	Prof. Dr. Helmut Cölfen
Educational objectives	Formation, analytics and properties of nanoparticles with focus on analytics.
Teaching content	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
Forms of teaching/ Amount of SWS	Lecture + exercise + seminars 4 SWS (2V / 2Ü)
Work load	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
Examination and unit completion	About 45 minutes of oral examination
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	Winter term

Nanochemistry and -analytics – Lab course

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

Credits	6 ECTS
Duration	1 Semester
Module grade	The module grade is composed of the grade for the practical work (50 %) and the grade for the written or oral report (50%).
Lecturer	Prof. Dr. Helmut Cölfen
Educational objectives	Formation, analytics and properties of nanoparticles.
Teaching content	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.
Forms of teaching/ Amount of SWS	Practical lab training
Work load	Practical lab training including report or oral presentation 210 h
Examination and unit completion	Report of the lab training resp. oral presentation (50 %) and performance in the laboratory (50 %)
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	According to the agreement

Polycyclic Natural Products and their Total Synthesis – Lecture

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 exam.
Lecturer	Prof. Dr. T. Gaich
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.
Teaching content	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.
Forms of teaching/ Amount of SWS	Lecture 2 SWS, Seminar 2 SWS
Work load	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.
Examination and unit completion	Written exam
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	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
Work load	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

Synthesis and Properties of Functional Materials – Lecture

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

Credits	6 ECTS
Duration	1 Semester
Module grade	The overall score of this course is the grade of the colloqium on the subject matter of the lecture
Lecturer	Prof. Dr. S. Mecking
Educational objectives	The particpants gain an in-depth understanding and knowlege 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, reversibel 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.
Forms of teaching/ Amount of SWS	Lecture + tutorial 4 SWS (3V/1Ü)
Work load	Lecture + tutorial: 15 weeks x 4 SWS 60 h Preparation and wrap-up 1.5h/contact hour 90 h Preparation oft he final exam 30 h 180 h
Examination and unit completion	Ca. 45 min. exam on the subject matter of the lecture.
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	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 particpants gain an in-depth understanding and knowlege 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, reversibel 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.
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

Credits	6 ECTS
Duration	1 Semester
Module grade	The module grade is the grade of the written exam.
Lecturer	Prof. Dr. T. Gaich
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.
Teaching content	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.
Forms of teaching/ Amount of SWS	Lecture 2 SWS, seminar 2 SWS
Work load	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.
Examination and unit completion	Written exam
Prerequisites	Bachelor in Chemistry / Bachelor in Life Science / Bachelor in Nanoscience
Language	English (German on request)
Time slot and frequency	Summer term

Synthesis of natural products and drugs – 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 students will learn state-of-the art synthetic techniques and synthetic methodology, will 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
Work load	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

Integrated Synthesis Practical Course for Master Students

Study Programme
Master Chemistry, Master Nanoscience

Credits	6 ECTS
Duration	1 Semester
Module grade	The grade is assigned according to the preparative output and a final colloquium.
Coordinator	A. Marx, T. Gaich, R. Winter, K. Betz, T. Huhn, M. Linseis
Educational objectives	In this module, students are introduced to modern aspects of the synthesis of inorganic and organic target compounds of different complexity. Learning objectives are the independent handling of preparative questions at a high level, as well as the identification and selection of suitable synthesis routes with the aid of databases such as REAXYS or SciFinder. In addition, the students become proficient in isolation techniques and purity control of the compounds with the help of chromatographic methods such as DC, GC, HPLC and the independent interpretation of spectroscopic data for structure elucidation. The students learn to report and write down their results adhering to scientific standards.
Teaching content	The course is split into two parts. Admission to second part is granted only upon successful completion of the first part. **First part** (approx. 3 weeks): Repetition and intensification of elementary concepts and skills in organic and inorganic synthesis represented by three prototypical preparations. **Second part** (entrance only after successful completion of part 1): One-step and multi-step syntheses (a total of 6 steps) are carried out related to current research topics of the department and the study focus of the student (Chemistry, Life Science, Nanoscience). Advanced preparative techniques are used such as inert gas, transition metal catalysts, working under high pressure or at low temperatures. Specific topics such as database research, separation methods (HPLC), structure determination methods, dynamic and multidimensional NMR spectroscopy, etc. are taught in selected seminars.
Forms of teaching/ Amount of SWS	Practical course 8 SWS
Work load	Practical course 150 h Preparation and protocols 15 h Two colloquia incl. preparation 15 h Σ 180 h

Examination and unit completion	A total of 9 synthesis steps, two colloquia (one after part 1 and a final examination).
Prerequisites	Bachelor in Chemistry / Bachelor in Nanoscience
Language	German, English
Time slot and frequency	Winter and summer term
Compulsory/Optional Courses	Compulsory course for students (Master Chemistry, Nanoscience) with admission requirements

Oral master's examination

Study programme
Master in Chemistry, Master in Life Science, Master in Nanoscience

Credits	15 ECTS credits
Duration	1 semester
Module grades	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.
Lecturers	University teachers from the Department of Chemistry
Educational objectives	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.
Teaching content	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.
Forms of teaching/ Amount of SWS	Self-study, meeting with university teachers, participation in guest lectures
Work load	450 hours
Examination and unit completion	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
Prerequisites	All course-related performance assessments stated in the study and examination regulations must have been completed
Language	English (German on request)
Time slot and frequency	Winter and summer semester

Master's thesis

Study programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	30 ECTS
Duration	6 months
Module grade	The grade for the master's thesis is calculated as the average from the grades determined by the two reviewers.
Lecturers	University teachers from the Department of Chemistry
Educational objectives	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.
Teaching content	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
Forms of teaching/ Amount of SWS	All-day instruction on scientifically working in a team
Work load	900 hours
Examination and unit completion	Writing of the master's thesis; recommended semester: 3rd-4th semester
Prerequisites	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
Language	English (German on request)
Time slot and frequency	Winter and summer semester

Master’s colloquium

Study Programme
Master Chemistry, Master Life Science, Master Nanoscience

Credits	15 ECTS credits
Duration	2 semesters
Module grades	This module is not graded
Lecturers	University teachers from the Department of Chemistry
Educational objectives	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.
Teaching content	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.
Forms of teaching/ Amount of SWS	Self-study and participation in colloquia
Work load	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
Examination and unit completion	Recommended semester: 3rd - 4th semester
Prerequisites	
Language	English (German on request)
Time slot and frequency	Winter and summer semester