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FACULTY OF MATHEMATICS
AND NATURAL SCIENCES

UNIVERSITY OF COLOGNE

MODULE COMPENDIUM / MODULHANDBUCH

MASTER OF SCIENCE in CHEMISTRY

ACCORDING TO THE EXAMINATION REGULATIONS FOR THE MASTER OF SCIENCE IN CHEMISTRY

Universität zu Köln

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✧ The module description follows the English language template: https://portal.unikoeln.de/subportale/qualitaetsmanagement-lehrestudium/downloads

Berücksichtigte Kommentare / Änderungen von:

Uwe Ruschwitz (xx.8.2023), Axel Klein (xx.8.2023), Elmar Behrmann (xx.8.2023),

1 The Master's Degree Chemistry

1.1 Content, Aims of Studies, and Requirements

The Master of Science program in Chemistry is research-oriented and taught in English. The successful completion of the two-year program will lead to a Master of Science (M.Sc.) degree. With the program, students will acquire a strong background in selected areas of advanced chemistry and in modern research practice. This will enable them to take up career paths in both university and company environments. The modules are spread over the main chemistry areas, including inorganic, organic, physical, and theoretical chemistry as well as biochemistry. Students can both extend and specialize their scientific knowledge.

In this study program, students learn to work on complex problems and to solve them using the scientific methods they have learned and advanced. In the Master's program, various specializations are offered for in-depth study. The orientation of the study program should enable students to gain an overview of interdisciplinary contexts and to apply scientific methods and findings independently, so that insights can also be gained beyond the current limits of the state of knowledge. This is to be achieved above all in the concluding Master's Thesis module. Due to its research-oriented focus, the Master's program qualifies students in particular for possible doctoral studies.

The requirements to participate in the Master's Degree Course Chemistry are specified in the Zulassungsordnung MZO (admission regulations).

1.2 Structure and Progression of the Studies

In the first semester (winter or summer term) of the program, students attend two **Advanced Modules A** and a **Scientific Literacy Module SL** (all Basic Modules/Basismodule) as well as one out of two **Research Focus Modules RF** (Advanced Modules/Aufbaumodule). The successful completion of the SL module as well as one of the A modules is prerequisite for the experimental modules in the following semesters.
There are two forms of experimental modules, the **Subject Modules** and the **Laboratory Project Modules** (SM, LM, Specialization Module/Schwerpunktmodule). The former are 8-week laboratory modules, covering different areas of modern chemistry (see Table 3). The second and third semester are dedicated to research and comprise two SM, two LM as well as one RF modules. One LM module is combined with the preparation of the **Project Proposal**, where students learn to write an application for funding related to the topic of their future research, e.g. the Master Thesis. In the two LM modules, students work in a research group of their own choice on a scientific question for 12 weeks, to develop a deeper understanding of experimental methods and techniques.
The program is completed with a six-month research project that will be written up in a Master's thesis and presented in a colloquium ("**Master Thesis**", (Specialization Module/Schwer-punktmodul)).

1.3 General CP-Survey

Professional Studies		90 CP (75%)
Master Thesis		30 CP (25%)
Total		120 CP

1.4 Term Based Schedule

Term	Basic Modules	Advanced Modules	Specialization Modules		Total CP
1	Advanced Chemistry A1 and A2 (whole term, 2x6 CP) Scientific Literacy (whole term, 9 CP)	Research Focus 1*, ** (6 CP)			27
2		Research Focus 2*, ** (6 CP)	Subject Module 1*, ** (12 CP) Subject Module 2*, ** (12 CP)		30
3				Laboratory Project Module 1*** (15 CP) Laboratory Project Module 2*** with project proposal (18 CP)	33
4				Master Thesis (30 CP)	30

* One Subject Module has to be completed before the first Laboratory Project Module can be performed
** Subject Modules have to be performed in different research groups.
*** Laboratory Project Modules have to be performed in different research groups.

1.5 Calculation of the Overall Grade

1	5%	Advanced Chemistry 1	A1
2	5%	Advanced Chemistry 2	A2
3	7,5%	Scientific Literacy	SL
4	5%	Research Focus 1	RF1
5	5%	Research Focus 2	RF2
6	10%	Subject Module 1	SM1
7	10%	Subject Module 2	SM2
8	12,5%	Laboratory Module 1	LM1
9	15%	Laboratory Module 2	LM2
10	25%	Master Thesis	MT
	100%	Total	

2 Module Descriptions

The study program contains **ten modules** and is initiated with three basic modules that define the common knowledge base of advanced chemistry students in two areas of chemistry.

The newly created **Scientific Literacy** (**SL**) module provides beginning students in the master's program with the essentials of scientific work that go beyond the skills already learned in the bachelor's program. In particular, aspects of scientific problem-solving strategies, ethical aspects of scientific work and the handling of data are in the foreground here. In addition, a three-week laboratory internship provides an opportunity to repeat and deepen familiar working techniques as well as to perform unfamiliar techniques for the first time. In this way, the level of training after a bachelor's degree can also be evaluated and problems in the continuing master's degree program can be made visible. In addition, the SL module serves as a group-building event where the first-year cohort can connect with their respective academic mentors, learn about specialization opportunities in the master's program, and network socially and professionally with other students or teaching assistants within and outside of the cohort.

In the **Advanced Chemistry** (**A**) lecture series, lecturers from all main areas of chemistry (biochemistry, inorganic, organic, physical, and theoretical chemistry) present core knowledge combined with cutting edge research. In this course, the Master students learn, recapitulate, and deepen their understanding of modern chemistry. The lecture course conveys general knowledge in advanced chemistry and prepares for the more specialized modules in organic chemistry.

In the **Research Focus** (**RF**) lecture series, lecturers from all main areas of chemistry (biochemistry, inorganic, organic, physical, theoretical) are presented from another perspective that differs from the area-specific focus that is characteristic for A-modules (and for all lecture modules in the Bachelor´s education).

Students have to successfully complete two **Subject Modules** (**SM**), preferably in the 2st and 3nd term. The Subject Modules aim to extend the knowledge in the respective research area with 8-week laboratory (practical part) and theoretical training (lecture part). Simultaneously, the students extend their skills of presenting scientific results in oral and written form. To better achieve these competencies, the subject modules contains reporting and presentation elements as prerequisites for the oral examinations.

The **Laboratory Module** (**LM1**) in the 2nd and 3rd term of the Master's degree course will help students learn how to actively integrate into a research group and extend their practical skills by means of a laboratory project of 12 weeks. In the second **Laboratory Module (LM2)**, a project proposal is integrated as course achievement, where students will write an application for funding closely related to the topic of their future master thesis. This is both a good test run for later applications and helps with the preparation of the module Master Thesis & Defense. A student may not perform both of these project modules in the same research group to ensure the broadest possible education.

The written Master Thesis is an integrative part of the module **Master Thesis**. Further information and regulations can be found in the module description as well as in the examination regulations of the Master's degree course.

The following tables give an overview of available modules. Detailed descriptions are listed afterwards.

2.1 Overview of general module types

The programme consists of seven general modules with 11 examination elements (+ 2 examination elements for the Master thesis & Defence). For each module all exam elements have to be passed to pass the overall module.

General Module Type*	General Module Name	Duration	Examination type** Module type	Credits
1 (BM)	Advanced Chemistry MN-C-A	Full semester, winter and summer term	1 exam element, facultative obligatory	2 x 6
	Advanced Biochemistry MN-C-A-BC	"	"	6
	Advanced Inorganic Chemistry MN-C-A-IC	"	"	6
	Advanced Organic Chemistry MN-C-A-OC	"	"	6
	Advanced Physical Chemistry MN-C-A-PC	"	"	6
	Advanced Theoretical Chemistry MN-C-A-TC	"	"	6
2 (BM)	Scientific Literacy MN-C-SL	Full Semester, winter and summer term	1 exam element, obligatory	1 x 9
3 (AM)	Research Focus MN-C-RF	Full Semester, winter and summer term	1 exam element, facultative obligatory	2 x 6
4 (SM)	Subject Module MN-C-SM	8 weeks	1 exam element, facultative obligatory	2 x 12
5 (SM)	Laboratory Project MN-C-LM1	3 months	1 exam element, facultative obligatory	1 x 15
6 (SM)	Laboratory Project MN-C-LM2_RP	3 months	1 exam element, facultative obligatory	1 x 18
7 (SM)	Master Thesis MN-C-MT	6 months	2 exam elements, facultative obligatory	1 x 30

* BM = basic modules; AM = advanced modules; SM = specialization modules; ** The proportional weighting of the individual examination elements for the total module grade is outlined in the individual module descriptions (No. 9);

2.2 Available Module Places

The programme consists of seven general modules with 9 examination elements (including 2 examination elements for the Master thesis & Defence). There is enough places available in all core and advanced modules for all students enrolled.

The number of laboratory places is limited for the SM and LM modules. A list of times and available places for **SM** and **LM** modules is published in good time (normally 2 months before the start of a semester). **SM** modules can be offered for the first or second half of the semester (or for both halves of the semester in the case of larger working groups).

In case a student cannot find a supervisor for these modules, it is the responsibility of the M.Sc. Chemistry Examination Committee to arrange for one.

2.3 **Basic Modules, Basismodule**

Scientific Literacy (SL)

ID	Workload	Credit Points	Term	Offered Every	Duration
MN-C-SL	270 h	9 CP	1st term	Summer and winter term	One semester

1	Course Types	Contact Times	Self-Study Times h	Group Size
	a) Seminar	36 h	54 h	
	c) Lab Exercises (3 weeks)	90 h	90 h	max 30

2	Module Objectives and Skills to be Acquired	**Ziele des Moduls und zu erwerben-de Fertigkeiten / Kompetenzen**
	Obtaining scientific results, understanding the “scientific method”	Erzielung wissenschaftlicher Ergebnisse, die "wissenschaftliche Methode"
	Reporting and presenting scientific results (reports, poster, talks)	Berichten und Präsentieren wissenschaftlicher Ergebnisse
	Discussing scientific results	Diskutieren von wissenschaftlichen Ergebnissen
	Management of scientific results / data management	Management von wissenschaftlichen Ergebnissen/Daten
	Outsourcing / commercialization of scientific results / data	Outsourcing / Kommerzialisierung von wissenschaftlichen Ergebnissen / Daten
	Principles of “Good Science”	Prinzipien der "Guten Wissenschaft"

3	Module Content • Obtaining scientific results: the scientific method • Data collection, data storage (see below) • Who is responsible, who owns data, legal aspects? • Documenting experimental data – how and when • Classical and electronic lab journals • Literature search and organization • Reporting/presenting scientific results: • Oral presentations. How to present own results / literature results / • Poster presentations • Writing papers • Ethic aspects of publication (bias, citation, plagiarism, author identification) • Open access principles • Discussing scientific results: • Basic rules for good scientific practice • Doubts in scientific results • Dialectic discussion in science • Defending (fair and unfair conditions) • Management of scientific results / data: Best practice for data collection right from beginning Best practice for data storage and transfer Best practice for data communication • Outsourcing / commercialization of scientific results / data: Intellectual property Collaboration and contract design Patenting and commercialization Outsourcing and foundation • "Good Science" Good scientific practice • Lab exercises (Dec /June) Lab module in one chemical discipline (different from topic of bachelor thesis) One Standard experiment with protocol as example with extensive corrections Individual experiments with protocols; last protocol will be part of the oral exam
4	Teaching Methods • Software demonstrations and tutorials • Seminar discussions, independent and group work • Writing exercises, Sample graphic design • Peer review
5	Prerequisites Good written English, good text software skills, knowledge of chemical graphics and data handling software
6	Type of Examination Oral presentation in the seminar and lab protocol are pre-requisites for the oral exam.

7	Credits Awarded 9 CPs
8	Compatibility with other Curricula Will be considered on an individual basis; master and predoctoral students
9	Proportion of Final Grade 9/120
10	Module Coordinator Dr. Heike Henneken, phone 470-1791, e-mail: hhenneke@uni-koeln.de Lecturers Prof. Ralf Giernoth, Prof. Axel Griesbeck, Prof. Annette Schmidt, Dr. Christian Logemann, Dr. Dadhichi Paretkar, Gabriele Schwiertz, Christiane Suthaus
11	Further Information Material and details regarding the course will be provided via an accompanying ILIAS course site online.

Advanced Biochemistry Module

Type of Module	**Module code**
Basic Module	A_BC

ID	**Workload**	**Credit Points**	**Study Semester**	**Offered Every**	**Start**	**Duration**
MN-C-A-BC	180 h	6 CP	1. semester	every semester	every semester	1 Semester

1	**Course types** a) Lecture b) Seminar	**Contact Time** 3 SWS / 45 h 1 SWS / 15 h	**Private Study** 120 h: Preparation and follow-up of lectures and seminars, preparation for exams and seminar presentations.
2	**Module objectives and skills to be acquired** Upon successful completion of the module, students will be able to: • describe the current aspects of Biochemistry and the main research fields in which this field is involved, • deal with challenging and advanced problems from different subfields of Biochemistry and independently develop approaches to solving them, • deal with a recent publication, understand its main content and relate it to other work in the field of Biochemistry, and then present on it in a comprehensible form to other students and face questions from students and lecturers.		
3	**Module content** Lecture part:		

	A selection from the following subfields A-D of Biochemistry will be covered: A) Structural biology • protein folding and stability • methods for the determination of the 3D structure of proteins • X-ray structural analysis in theory • structure and function of proteins B) Biogenesis and function of enzymes and cofactors • purification techniques and analysis of proteins and small molecules • enzyme characterization and inhibition • biophysical characterization of proteins and small molecules • protein expression and affinity chromatographic purification • assembly of protein complexes • fermentation and purification of cofactor precursors • synthesis of metal cofactors and insertion into apo enzymes • mass spectrometric characterization of proteins C) Neurobiochemistry • Structure and function of neurons • Voltage-gated and ligand-gated ion channels • Postsynaptic proteins and structures • Neuron receptors in health and disease • Methods for visualization of cellular structures and protein interactions (in vitro and in vivo) D) Synthesis and application of biologically active peptides • Peptide synthesis at the solid phase • Protective group concepts and introduction of functional groups <u>Seminar part:</u> In the seminar, students will present in lectures various selected research results in an above-mentioned area of Biochemistry based on current literature. A selection list with literature topics to be worked on will be announced in time.
4	**Teaching methods** Research-oriented, partially interactive lectures (e.g. with audience response systems) video-taped (if possible); Seminars are research-oriented and interactive (open for discussion between students and thematic mentors).
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** none
6	**Type of examination:** written examination (120 min) about the topics of the lecture **Requirements for examination:** successful (i.e. accepted by the seminar coordinator, under the conditions: time frame 15 ± 2 min, acceptable structure of the presentation including introduction, explanations and summary, language in understandable quality, consistency of the presented files, persuasive discussion behavior, appropriate references) oral presentation of the student in the course of the seminar **Examination restrictions:** three attempts
7	**Credits awarded** Written examination at least “sufficient”
8	**Compatibility with other curricula** -

9	**Proportion of final grade** 5% (6/120)
10	**Module coordinators** Prof. Dr. G. Schwarz, Prof. Dr. J. Riemer, Prof. Dr, U. Baumann, Prof.´ Dr.´ I. Neundorf, Prof. Dr. E. Behrmann, Prof. Dr. K. Niefind, N.N.
11	**Further information** Literature list and seminar topics are made available and updated via **ILIAS**.

Advanced Inorganic Chemistry Module

Type of Module	Module code
Basic Module	A_IC

ID	Workload	Credit points	Term	Offered every	Start	Duration
MN-C-A-IC	180 h	6 CP	1. semester	every semester	every semester	1 Semester

1	**Course types** a) Lecture b) Seminar	**Contact time** 3 SWS / 45 h 1 SWS / 15 h	**Private study** 120 h: Preparation and follow-up of lectures and seminars, preparation for exams and seminar presentations.

2 Module objectives and skills to be acquired

Upon successful completion of the module, students will be able to:

- describe the current aspects of Inorganic Chemistry and the main research fields in which this field is involved,
- deal with challenging and advanced problems from different subfields of Inorganic Chemistry and independently develop approaches to solving them,
- deal with a recent publication, understand its main content and relate it to other work in the field of Inorganic Chemistry, and then present on it in a comprehensible form to other students and face questions from students and lecturers.

3 Module content

Lecture part:

A basic and self-contained lecture from a subfield of modern inorganic chemistry:

- Molecular chemistry of s- and p-block elements in the context of modern bonding concepts;
- Coordination chemistry of organometallic complexes: Structure and bonding relationships in complexes; typical reactions and properties of complexes: Ligand exchange, ligand activation, electron transfer, optical and magnetic properties; application of complexes in analytics, materials, metal-organic homogeneous catalysis and biocatalysis;
- Solid state chemistry and chemistry of nanostructured materials: preparative solid state chemistry, fundamentals of understanding nanostructures, synthesis of nanomaterials, reactions in the gas phase (chemical transport, vapor deposition), reactions in solution (precipitates, colloids, sol-gel chemistry, solvo-hydrothermal synthesis), reactions of organometallic reagents in materials synthesis, precursor concept.

Other contents may supplement or substitute the thematic extent depending on timely notification (one semester prior to the start of the module).

Seminar part:

In the seminar, students will present in lectures various selected research results in an above-mentioned area of Inorganic Chemistry based on current literature. A selection list with literature topics to be worked on will be announced in time.

4 Teaching methods

	Research-oriented, partially interactive lectures (e.g. with audience response systems) video-taped (if possible); Seminars are research-oriented and interactive (open for discussion between students and thematic mentors).
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** none
6	**Type of examination:** written examination (120 min) about the topics of the lecture **Requirements for examination:** successful (i.e. accepted by the seminar coordinator, under the conditions: time frame 15 ± 2 min, acceptable structure of the presentation including introduction, explanations and summary, language in understandable quality, consistency of the presented files, persuasive discussion behavior, appropriate references) oral presentation of the student in the course of the seminar **Examination restrictions:** three attempts
7	**Credits awarded** Written examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 5% (6/120)
10	**Module coordinators** Prof. Dr. U. Ruschewitz, Prof. Dr. A. Klein, Prof. Dr. M. Wickleder, Prof. Dr. S. Mathur, Dr. J. Bruns
11	**Further information** Literature list and seminar topics are made available and updated via **ILIAS**.

Advanced Organic Chemistry Module

Type of Module	**Module code**
Basic Module	A_OC

ID	**Workload**	**Credit points**	**Term**	**Offered every**	**Start**	**Duration**
MN-C-A-OC	180 h	6 CP	1. semester	every semester	every semester	1 Semester

1	**Course types** a) Lecture b) Seminar	**Contact time** 3 SWS / 45 h 1 SWS / 15 h	**Private study** 120 h: Preparation and follow-up of lectures and seminars, preparation for exams and seminar presentations.
2	**Module objectives and skills to be acquired** Upon successful completion of the module, students will be able to: • describe the current aspects of Organic Chemistry and the main research fields in which this field is involved,		

	• deal with challenging and advanced problems from different subfields of Organic Chemistry and independently develop approaches to solving them, • deal with a recent publication, understand its main content and relate it to other work in the field of Organic Chemistry, and then present on it in a comprehensible form to other students and face questions from students and lecturers.
3	**Module content** Lecture part: A basic and self-contained lecture from a subfield of modern Organic Chemistry: • Physical Organic Chemistry: general concepts, thermodynamics and kinetics, isotope effects and labeling, Hammett and related correlations, pericyclic reactions; • Catalysis: general concepts, acid-base catalysis, transition metal catalysis, organocatalysis, biocatalysis, photocatalysis and combined methods; • Heterocycles and natural products: synthesis methods for heterocycles, classes of natural products, occurrence and importance of heterocycles and natural products; • Advanced synthetic chemistry: retrosynthesis, total synthesis of complex natural products; • Sustainable and gree chemistry. Other contents may supplement or substitute the thematic extent depending on timely notification (one semester prior to the start of the module). Seminar part: In the seminar, students will present in lectures various selected research results in an above-mentioned area of Organic Chemistry based on current literature. A selection list with literature topics to be worked on will be announced in time.
4	**Teaching methods** Research-oriented, partially interactive lectures (e.g. with audience response systems) video-taped (if possible); Seminars are research-oriented and interactive (open for discussion between students and thematic mentors).
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** none
6	**Type of examination:** written examination (120 min) about the topics of the lecture **Requirements for examination:** successful (i.e. accepted by the seminar coordinator, under the conditions: time frame 15 ± 2 min, acceptable structure of the presentation including introduction, explanations and summary, language in understandable quality, consistency of the presented files, persuasive discussion behavior, appropriate references) oral presentation of the student in the course of the seminar **Examination restrictions:** three attempts
7	**Credits awarded** Written examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 5% (6/120)
10	**Module coordinators**

	Prof. Dr. S. Kath-Schorr, Prof. Dr. B. Goldfuss, Prof. Dr. R. Giernoth, Prof. Dr. M. Schäfer, Prof. Dr. A. Griesbeck, Dr. D. Blunk
11	**Further Information** Literature list and seminar topics are made available and updated via **ILIAS**.

Advanced Theoretical Chemistry Module

Type of Module	**Module code**
Basic Module	A_TC

ID	**Workload**	**Credit points**	**Term**	**Offered every**	**Start**	**Duration**
MN-C-A-TC	180 h	6 CP	1. semester	every semester	every semester	1 Semester

1	**Course types** a) Lecture b) Exercise	**Contact time** 3 SWS / 45 h 1 SWS / 15 h	**Private study** 120 h: Preparation and follow-up of lectures and seminars, preparation for exams and seminar presentations.

2 Module objectives and skills to be acquired

Upon successful completion of the module, students will be able to:

- describe the current aspects of Theoretical Chemistry and the main research fields in which this field is involved,
- deal with challenging and advanced problems from different subfields of Theoretical Chemistry and independently develop approaches to solving them,
- deal with a recent publication, understand its main content and relate it to other work in the field of Theoretical Chemistry, and then present on it in a comprehensible form to other students and face questions from students and lecturers.

3 Module content

Lecture part:

A selection from the following subfields of physical chemistry will be covered:

- Model of independent particles, electron correlation
- Self-consistent field (SCF) method
- Hartree-Fock method (HF)
- Density Functional Method (DFT)
- Configuration Interaction method (CI)
- Coupled Cluster Approach (CC)
- Many-body Perturbation Theory (MBPT)
- Relativistic effects
- Solvent effects
- Coupling of quantum chemical and classical mechanical methods (QM/MM)
- Classical molecular dynamics and Car-Parrinello molecular dynamics (CPMD)

Seminar part:

	In the seminar, students will present in lectures various selected research results in an above-mentioned area of Theoretical Chemistry based on current literature. A selection list with literature topics to be worked on will be announced in time.
4	**Teaching methods** Research-oriented, partially interactive lectures (e.g. with audience response systems) video-taped (if possible);
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** none
6	**Type of examination:** written examination (120 min) about the topics of the lecture **Examination restrictions:** three attempts
7	**Credits awarded** Written examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 5% (6/120)
10	**Module coordinators** Prof. Dr. M. Hanrath, N.N.
11	**Further information** Literature list and seminar topics are made available and updated via **ILIAS**.

Advanced Physical Chemistry Module

Type of Module	**Module code**
Basic Module	A_PC

ID	**Workload**	**Credit points**	**Term**	**Offered every**	**Start**	**Duration**
MN-C-A-PC	180 h	6 CP	1. semester	every semester	every semester	1 Semester

1	**Course types** a) Lecture b) Exercise	**Contact time** 3 SWS / 45 h 1 SWS / 15 h	**Private study** 120 h: Preparation and follow-up of lectures and seminars, preparation for exams and seminar presentations.
2	**Module objectives and skills to be acquired** Upon successful completion of the module, students will be able to: • describe the current aspects of Physical Chemistry and the main research fields in which this field is involved,		

	• deal with challenging and advanced problems from different subfields of Physical Chemistry and independently develop approaches to solving them, • deal with a recent publication, understand its main content and relate it to other work in the field of Physical Chemistry, and then present on it in a comprehensible form to other students and face questions from students and lecturers.
3	**Module content** Lecture part: A selection from the following subfields of physical chemistry will be covered: Spectroscopy (rotational and vibrational transitions, electron transitions, lasers, magnetic resonance); statistical thermodynamics (fundamentals and applications); electrical and magnetic properties of molecules; macromolecules; surfaces and interfaces. Other contents may supplement or substitute the thematic extent depending on timely notification (one semester prior to the start of the module). Seminar part: In the seminar, students will present in lectures various selected research results in an above-mentioned area of Physical Chemistry based on current literature. A selection list with literature topics to be worked on will be announced in time.
4	**Teaching methods** Research-oriented, partially interactive lectures (e.g. with audience response systems) video-taped (if possible);
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** none
6	**Type of examination:** written examination (120 min) about the topics of the lecture **Examination restrictions:** three attempts
7	**Credits awarded** Written examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 5% (6/120)
10	**Module coordinators** Prof.´ Dr.´ A. Schmidt, Prof. Dr. K. Meerholz, Prof. Dr. M. Gather, Prof. Dr. K. Lindfors, Prof. Dr. M. Schubert, N.N.
11	**Further information** Literature list and seminar topics are made available and updated via **ILIAS**.

2.4 Advanced Module, Aufbaumodule

Computational Chemistry (CompChem)	
Art des Moduls • Research Fokus Modul	**Kurztitel** MS+CC

Kenn-nummer	Workload	Leistungs-punkte	Studien-semester	Häufigkeit des Angebots	Beginn des Angebots	Dauer
MN-C-MS+CC	180 h	6	1. oder 2. Semester	Jedes WiSe	WiSe24/25	1 Semester

1	**Lehrveranstaltungen** a) Vorlesung (VL) b) Seminar/Übung (Se/Ü)	**Kontaktzeit** 2 SWS / 30 h 1 SWS / 15 h	**Selbststudium** 60h/75h Vor- und Nachbereitung

2 Ziele des Moduls und zu erwerbende Kompetenzen

- Conduction of Own Calculations
- Choice of Appropriate Methods for Application
- Cost Estimation of Intended Calculation Method
- What Kind of Properties are Suitable for Calculation
- Critical Assessment of Accuracy and Applicability
- Awareness of Potential Traps and Approximations
- Capability of Using Computational Program Packages and Visualization Tools
- Using (Large) Computer Clusters, Managing Calculations, Collection of Results

3 Inhalte des Moduls

- Software Tools: Linux, Shell Commands, Scripting, ssh, slurm, Job Submission
- Introduction to Computational Methods, Basic Theoretical Background
  - Energetics, Potential Surfaces, (Reaction) Coordinates
  - Characterization of Stationary Points
  - Basic Thermodynamics, Reaction Barriers, Reaction Rates
  - Methods of Computations
    - Force Fields
    - Wavefunction
    - Semiempirical
    - Density Functional
- Introduction to Program Packages, e.g. Orca, Turbomole, Gaussian, Schrödinger Suite, AutoDock Vina
- Visualization Tools, e.g. Gaussview, Avogadro, VMD
- Example Applications
  - Characterization of Stationary Points
  - Alder's Endo-Rule
  - Reactivities and Selectivities in Diels-Alder Additions
  - Protein Structures
  - Molecular Dynamics

4 Lehr- und Lernformen

Vorlesung; Seminar/Übung mit eigenem Arbeiten am Rechner

5 Modulvoraussetzungen

Formal: keine

Inhaltlich: keine

6	**Form der Modulprüfung/Modulabschlussprüfung** **Prüfungsvoraussetzung:** keine **Abschlussprüfung:** Kolloquium
7	**Voraussetzungen für die Vergabe von Leistungspunkten**
8	**Verwendung des Moduls (in anderen Studiengängen)** M. Sc. Computational Science
9	**Gesamtnote/Fachnote**
10	**Modulbeauftragte*r** Prof. Dr. Michael Hanrath, Department für Chemie, Institut für Licht und Materialien **Dozenten:** PD Dr. Dirk Blunk, Prof. Bernd Goldfuß
11	**Sonstige Informationen** **Empfohlene Literatur:** • Christopher H. Cramer, Essentials of Computational Chemistry - Theories and Models, John Wiley & Sons, 2002 • Frank Jensen, Introduction to Computational Chemistry, John Wiley & Sons, 2007 • Applications Manual of Computational Program Suites, available online

From Molecules to Mice to Man

Art des Moduls	**Kurztitel**
• Research Fokus Modul	MMM

Kenn-nummer	**Workload**	**Leistungs-punkte**	**Studien-semester**	**Häufigkeit des Angebots**	**Beginn des Angebots**	**Dauer**
MN-C-MMM	180 h	6	1. oder 2. Semester	Jedes WiSe	WiSe24/25	1 Semester

	Lehrveranstaltungen	**Kontaktzeit**	**Selbststudium**
1	a) Vorlesung (VL) b) Seminar (Se) c) Imaging Labor/RRZK Cave	3 SWS / 45 h 1 SWS / 15 h 10 h	60h/60h Vor- und Nachbereitung

2 **Ziele des Moduls und zu erwerbende Kompetenzen**

- Concepts of (molecular) Imaging and Image-guided Drug Delivery
- Understanding of medical imaging technology (CT, MRI, PET, SPECT)
- Basic concepts of pharmacokinetics/pharmacodynamics (PKPD)
- Fundamentals of radiochemistry and radiolabeling

	• Contrast agents and tracers by modality and applications • Preclinical molecular imaging: a research tool • Clinical (molecular) imaging: addressing appplications, clinical diagnostics/therapy • Data analysis, radiomics, AI in imaging
3	**Inhalte des Moduls** • Imaging systems: → Overview on *computed tomography* (CT), *magentic resonance imaging* (MRI), *positron emmission tomography* (PET), *single photom emission computed tomography* (SPECT), difference between preclinical and clinical systems. • Exemplary studies of contrast agents/tracers with respect to their PKPD. Where do they go upon injection? • Radiochemistry: → decay schemes of radionuclides used in medicine, radiolabeling, specific acivity → radiolabeling of molecules, covalent chemistry, chelates • Synthesis of contrast agents and tracers → peptide probes, → small organic molecules, MRI contrast agents (dendrimers, nanoparticles) etc. • Preclinical research using molecular Imaging → neurology, oncology, reporter gene imaging, → MRI & high intensity focused ultrasound (HIFU) & smart materials for drug delivery • Clinical examples of molecular imaging and theranostics → PSMA PET & therapy, octreotide, FAPI… • Data Analysis using Ai and radiomics approaches, data visualization
4	**Lehr- und Lernformen** • Vorlesung (45 h) • Seminar mit Präsentation (15) • Lab course in imaging facility, hands on MRI, SPECT (7 hours) • Visit to the CAVE (RRZK), 3D data visualization (3 hours)
5	**Modulvoraussetzungen** **Formal:** keine **Inhaltlich:** keine
6	**Form der Modulprüfung/Modulabschlussprüfung** **Prüfungsvoraussetzung:** keine **Abschlussprüfung:** Kolloquium
7	**Voraussetzungen für die Vergabe von Leistungspunkten**
8	**Verwendung des Moduls (in anderen Studiengängen)** M.Sc. Neuroscience
9	**Gesamtnote/Fachnote**
10	**Modulbeauftragte*r** Prof. Holger Grüll (Chemie), apl.-Prof. Heike Endepols (Biologie)

11	**Sonstige Informationen.**

Mass Spectrometry (MS) and its Application in Atmospheric Chemistry (AAC)

Art des Moduls	**Kurztitel**
• Research Fokus Modul	MSAAC

Kenn-nummer	**Workload**	**Leistungs-punkte**	**Studien-semester**	**Häufigkeit des Angebots**	**Beginn des Angebots**	**Dauer**
MN-C-MSAAC	180 h	6	1. oder 2. Semester	Jedes WiSe	WiSe24/25	1 Semester

	Lehrveranstaltungen	**Kontaktzeit**	**Selbststudium**
1	a) Vorlesung (VL) b) Seminar (Se)	3 SWS / 45 h 1 SWS / 30 h	60h/60h Vor- und Nachbereitung

2 **Ziele des Moduls und zu erwerbende Kompetenzen**

- Fundamental understanding of Atmospheric Chemsitry
- Fundamental understanding of MS instrumentation
- Application of MS means to analyze complex (gaseous) reaction mixtures
- Application of MS means to investigate reaction mechanisms, catalytic circles, labile reaction intermediates
- Atmospheric constituents and processes
- Aerosols and aerosol sour*ces*
- Impact of atmospheric processes and constituents on climate

3 **Inhalte des Moduls**

- MS Instrumentation

→ Overview on relevant ionisation methods:
Elektron Ionisation EI, Chemical Ionisation CI, Plasmadesorption, Electrospray
→ MS Analysators: TOF, Quadrupol, Orbitrap, Tandem-MS: QqQ, QqTOF, RE-TOF, Ion Mobility IMS (Flow Tuve IMS, FAIMS, TIMS, Traveling wave IMS etc.)

- Exemplary Studies to elucidate transient reaction intermediates and mechanisms in the gas phase.
- Important atmospheric oxidation processes

→ OH, O_3, NO_3, daytime and nighttime oxidation

- Atmospheric volatile organic compounds (VOCs)

→ Biogenic and anthropogenic VOCs, anthropogenic trace gases, e.g., NO, CH4, etc.

- Atmospheric Aerosol

→ Composition, Primary and secondary aerosols, formation of secondary organic aerosols, biogenic vs. anthropogenic, formation of highly oxidized molecules from VOC precursors, nucleation (new particle formation) vs. condensation (onto existing aerosol particles)

- Impact on climate and possibly climate change

→ Cloud formation from cloud condensation nuclei (CCN), cloud processing, indirect and direct radiative forcing of aerosol particles

4	**Lehr- und Lernformen** Vorlesung; Seminar mit Präsentation
5	**Modulvoraussetzungen** **Formal:** keine **Inhaltlich:** keine
6	**Form der Modulprüfung/Modulabschlussprüfung** **Prüfungsvoraussetzung:** keine **Abschlussprüfung:** Kolloquium
7	**Voraussetzungen für die Vergabe von Leistungspunkten**
8	**Verwendung des Moduls (in anderen Studiengängen)** B. Sc. Biochemie
9	**Gesamtnote/Fachnote**
10	**Modulbeauftragte*r** Prof. Dr. Mathias Schäfer, Department für Chemie, Institut für Organische Chemie, UzK
11	**Sonstige Informationen** **Weitere Dozenten** Dr. Sören Zorn FZ Jülich und PD Michael Hanrath, Theoretische Chemie UzK **Empfohlene Literatur:** • Jürgen H. Gross, Mass Spectrometry – A Textbook, 3rd Ed,Springer, 2017. • John H. Seinfeld & Spyros N. Pandis, Atmospheric Chemistry and Physics, 2016

2.5 Specialization Modules, Schwerpunktmodule

Subject Modules (SM1 and SM2)

Type of Module	Module code
Specialization Module	SM

ID	Workload	Credit Points	Term	Offered every	Start	Duration
MN-C-SM	360 h	12 CP	2.-3. semester	every semester	every semester	½ Semester

1	**Course types** a) Lecture b) Practical / Lab c) Seminar	**Contact time** 1 SWS / 15 h 200 h 12h	**Private study** 48 h: Preparation and follow-up of the lecture; 50 h: Report preparation, data evaluation and follow-up of the practical part; 35 h: preparation for exams and result presentations.

2 **Module objectives and skills to be acquired**

Upon successful completion of the module, students:

- will be able to describe the current aspects of a specific research field of chemistry and the main research applications in which this field is involved,
- have acquired detailed knowledge on the experimental techniques and analytical / spectroscopical tools of a subdiscipline in chemistry,
- can independently carry out small scientific projects related to the topics of the module,
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level,
- are able transfer experimental skills acquired in this module to other fields of Chemistry

3 **Module content**

Lecture part:

An advanced and self-contained lecture from a defined subfield of modern chemistry with modern applications and in-depth discussion of up-to-date research results.

Lab part:

In the practical / lab work (project-oriented work), guidance to independent research, training on modern lab techniques and analytical methods are offered.

Seminar part:

In the seminar, topical research results are presented and discussed and students will present their research results in an above-mentioned area of chemistry based on current literature.

4 **Teaching methods**

	Lectures, Practical / lab work (project-oriented work), interactive seminar, guidance to independent research, training on modern lab techniques and analytical methods, training on presentation techniques in oral and written form.
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** Successful completion of one A module and the Scientific Literacy module.
6	**Type of examination:** oral examination (30-45 min) about the topics of the module (lecture and lab course). **Requirements for examination:** a) successful (i.e. accepted by the lab coordinator, under the conditions: acceptable structure of the presentation including introduction, explanations and summary, language in understandable quality, consistency of the presented files, appropriate references) research / lab seminar presentation of the student in the course of the seminar and b) successfully (concerning scope, style, content, scientific correctness and significance, clarity of data presentation and interpretation of results, literature discussion and citations) audited internship report. This report on the experimental part of the module must be submitted for evaluation three weeks after completion of the laboratory part. **Examination restrictions:** none
7	**Credits awarded** Oral examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 10% (12/120)
10	**Module coordinators** All participating lecturers of the module, depending on the subfield.
11	**Further information** The subject modules should preferably be carried out in the working groups of the Department of Chemistry and in associated chemical research groups (e.g. at the Forschungszentrum Jülich or other non-university research centers). In exceptional cases, one (and only one) of the two SM modules can be carried out at non-university research groups or at associated non-chemical research groups (e.g. medicinal, physical, pharmaceutical research groups), but only after application to the chairman of the Master's examination board and final module examination by an authorized member of the Department of Chemistry. The two SM modules may not be carried out in two research groups of the Department of Chemistry that are attributed to the same Institute.

Lab Module 1 (LM1)

Type of Module	**Module code**
Specialization Module	LM1

ID	**Workload**	**Credit points**	**Term**	**Offered every**	**Start**	**Duration**

MN-C-LM1	450 h	15 CP	3. semester	every semester	every semester	½ Semester

1	**Course types** a) Practical / Lab b) Seminar	**Contact time** 360 h 12h	**Private study** 78 h: Report preparation, data evaluation and follow-up of the practical part; preparation for exams and result presentations.

2

Module objectives and skills to be acquired

Upon successful completion of the module, students:

- have learned to do detailed scientific work in a specific field of a given research group,
- have understood how to plan and conduct a small scientific project,
- have gained experience in following the presentation of scientific material by others in the frame of the seminar program of a research group,
- can actively participate in the discussions of the supervising working group in seminars on this topic, but also on related research projects,
- have learned how to present their own research results in oral and written form and to critically discuss scientific publications,

3

Module content

Laboratory part:

The detailed content of the Laboratory Module is proposed by the scientific supervisor on an individual basis in agreement with the student.

Seminar part:

In the seminar, topical research results are presented and discussed and students will present in a presentation their research results in an above-mentioned area of chemistry based on current literature.

Selected topics offered by the Department of Chemistry (2023):

- Bioorganic chemistry, RNA chemistry, biolabeling techniques
- Radionuclide production, organic radiochemistry, labeling chemistry
- Relativistic quantum chemistry, computational chemistry
- Enantioselective catalysis and synthesis, organometallic chemistry
- Photochemistry, radical chemistry, electron transfer chemistry
- Isolation, structure elucidation and biosynthesis of natural products
- Organic light emitting materials (OLEDs and PLEDs)
- Modern applications and basic aspects of bionanophotonics
- Organic solar cells and holographic memories
- Solid-state and coordination chemistry of non-metallic materials
- Preparative inorganic molecular chemistry
- Coordination polymers and metal-organic framework compounds
- Coordination chemistry, electrochemistry, organometallic chemistry
- Synthesis of novel catalysts, organo- and electron-transfer catalysis
- Environmentally sustainable ("green") chemistry, ionic liquids
- Macromolecular chemistry, polymer layers and polymer membranes
- Functional materials, supramolecular chemistry, molecular switches
- Modern methods of mass spectrometry

	• Modern methods of nuclear magnetic resonance spectroscopy • Modern methods of solid state analysis with X-ray diffraction methods • Chemical nanotechnology, functionalities in materials and molecules • Nanomaterials in biological systems and biomedical applications • Surface and interface analysis • Magnetic nanostructures: nanomagnetism, X-ray and neutron scattering techniques
4	**Teaching methods** Practical / lab work (project-oriented work), interactive seminar, guidance to independent research, training on modern lab techniques and analytical methods, training on presentation techniques in oral and written form.
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** Successful completion of one A module, the Scientific Literacy module, and one Subject module.
6	**Type of examination:** Paper presentation and discussion about the topics of the module. **Requirements for examination:** a) successful (i.e. accepted by the lab coordinator, under the conditions: acceptable structure of the presentation including introduction, explanations and summary, language in understandable quality, consistency of the presented files, appropriate references) research / lab seminar presentation of the student in the course of the seminar and b) successfully (concerning scope, style, content, scientific correctness and significance, clarity of data presentation and interpretation of results, literature discussion and citations) audited internship report. This report on the experimental part of the module must be submitted for evaluation three weeks after completion of the laboratory part. **Examination restrictions:** none
7	**Credits awarded** Examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 12,5% (15/120)
10	**Module coordinators** All participating lecturers of the module, depending on the subfield.
11	**Further information** The Lab Modules should preferably be carried out in the research groups of the Department of Chemistry and in associated chemical research groups (e.g. at the Forschungszentrum Jülich or other non-university research centers). Both LM modules, **LM1** and **LM2**, can be carried out at non-university research groups or at associated non-chemical research groups (e.g. medical, physical, pharmaceutical research groups), but only after application and approval to/by the chairperson of the Master Examination Committee and final module examination by an authorized member of the Department of Chemistry. LM modules may also be conducted externally at universities, non-university research institutions, industrial research laboratories in Germany and abroad. In all cases, an authorized member of the Chemistry Department is officially responsible for this module and must also conduct the final examination after completion of the module.

	The two **LM** modules may not be carried out in two research groups of the Department of Chemistry that are attributed to the same Institute. Consultation with the academic mentor is strongly encouraged in all such cases. Alternatively, this advice may be provided by the scientific coordinator or the chair of the Master's Examination Committee.

Lab Module 2 (LM2, with research proposal)

Type of Module	**Module code**
Spezialisation Module	LM2

ID	**Workload**	**Credit points**	**Term**	**Offered every**	**Start**	**Duration**
MN-C-LM2	540 h	18 CP	3. semester	every semester	every semester	½ Semester

1	**Course types** a) Practical / Lab b) Seminar	**Contact time** 360 h 12h	**Private study** 48 h: Report preparation, data evaluation; preparation for exams and result presentations. 120 h: Preparation and presentation of the research proposal

2 Module objectives and skills to be acquired

Upon successful completion of the module, students:

- will be able to describe the current aspects of a specific research field of chemistry and the main research applications in which this field is involved,
- have acquired detailed knowledge on the experimental techniques and analytical / spectroscopical tools of a subdiscipline in chemistry,
- can independently carry out small scientific projects related to the topics of the module,
- have learned how to present research results in oral and written form and to critically discuss scientific publications related to the topic of the module on a professional level,
- have learned to search the literature, to identify papers with important impact in the field and to extract relevant information in respect to their own research topic,
- are able to develop a working hypothesis, theory or model that explains a chemical mechanism and/or problem which has been studied in a research project,
- are able to propose reasonable experiments and define expected positive and negative outcomes including control experiments,
- are able to develop a work plan using different and complementary experimental approaches to prove or disprove their hypothesis
- have learned to describe and to critically discuss a state-of-the-art method
- have learned to describe and to critically discuss a state-of-the-art method

3 Module content

	Laboratory part: Research practical course in a current subfield of chemistry (list of subfields); the selection is made after consultation with the lecturers and is based on the current range of teaching and research. In these subfields, assignments are given for independent work under the guidance of, for example, a graduate student. Research proposal part: The research proposal can be written either (a) before the project module, (b) during the project module (and then also integrated into the report on the project module), or (c) after the project module has been carried out as a retrospective analysis. Seminar part: In the seminar, topical research results are presented and discussed, and students will present in a presentation their research results in an above-mentioned area of chemistry based on current literature. Selected topics offered by the Department of Chemistry (2023): • Bioorganic chemistry, RNA chemistry, biolabeling techniques • Radionuclide production, organic radiochemistry, labeling chemistry • Relativistic quantum chemistry, computational chemistry • Enantioselective catalysis and synthesis, organometallic chemistry • Photochemistry, radical chemistry, electron transfer chemistry • Isolation, structure elucidation and biosynthesis of natural products • Organic light emitting materials (OLEDs and PLEDs) • Modern applications and basic aspects of bionanophotonics • Organic solar cells and holographic memories • Solid-state and coordination chemistry of non-metallic materials • Preparative inorganic molecular chemistry • Coordination polymers and metal-organic framework compounds • Coordination chemistry, electrochemistry, organometallic chemistry • Synthesis of novel catalysts, organo- and electron-transfer catalysis • Environmentally sustainable ("green") chemistry, ionic liquids • Macromolecular chemistry, polymer layers and polymer membranes • Functional materials, supramolecular chemistry, molecular switches • Modern methods of mass spectrometry • Modern methods of nuclear magnetic resonance spectroscopy • Modern methods of solid state analysis with X-ray diffraction methods • Chemical nanotechnology, functionalities in materials and molecules • Nanomaterials in biological systems and biomedical applications • Surface and interface analysis • Magnetic nanostructures: nanomagnetism, X-ray and neutron scattering techniques
4	**Teaching methods** Lectures, Practical / lab work (project-oriented work), interactive seminar, guidance to independent research, training on modern lab techniques and analytical methods, training on presentation techniques in oral and written form.
5	**Prerequisites (for the module)** **Formal requirements:** Enrolment in the Master´s degree course “Chemistry” **Additional academic requirements:** Successful completion of one A module, the Scientific Literacy module, and one Subject Module.
6	**Type of examination:** Poster presentation about the topics of the module. **Requirements for examination:**

	a) successful (i.e. accepted by the lab coordinator, under the conditions: acceptable structure of the presentation including introduction, explanations and summary, language in understandable quality, consistency of the presented files, appropriate references) ***research / lab seminar presentation*** of the student in the course of the seminar, b) successfully (concerning scope, style, content, scientific correctness and significance, clarity of data presentation and interpretation of results, literature discussion and citations) audited ***internship report***. This report on the experimental part of the module must be submitted for evaluation three weeks after completion of the laboratory part, and c) successfully audited ***research proposal*** with the following minimum requirements: no page limit, English language, introduction to a research problem, clear research question, statement of the state of the literature with references, description of research strategy(s) and correct citations, possible solutions, project ideas, key experiments, description of a work program with "milestones" and development of a realistic schedule, RP is presented and "defended" in the working group, further discussion: oral exam of the LM2-module (content can also be included there, but does not have to). **Examination restrictions:** none
7	**Credits awarded** Oral examination at least “sufficient”
8	**Compatibility with other curricula** -
9	**Proportion of final grade** 15% (18/120)
10	**Module coordinators** All participating lecturers of the module, depending on the subfield.
11	**Further information** The Lab Modules should preferably be carried out in the research groups of the Department of Chemistry and in associated chemical research groups (e.g. at the Forschungszentrum Jülich or other non-university research centers). Both LM modules, **LM1** and **LM2**, can be carried out at non-university research groups or at associated non-chemical research groups (e.g. medical, physical, pharmaceutical research groups), but only after application and approval to/by the chairperson of the Master Examination Committee and final module examination by an authorized member of the Department of Chemistry. LM modules may also be conducted externally at universities, non-university research institutions, industrial research laboratories in Germany and abroad. In all cases, an authorized member of the Chemistry Department is officially responsible for this module and must also conduct the final examination after completion of the module. The two **LM** modules may not be carried out in two research groups of the Department of Chemistry that are attributed to the same Institute. Consultation with the academic mentor is strongly encouraged in all such cases. Alternatively, this advice may be provided by the scientific coordinator or the chair of the Master's Examination Committee.

Master Thesis

Type of Module	**Module code**
Specialisation Module	MT

ID	**Workload**	**Credit points**	**Term**	**Offered every**	**Start**	**Duration**
MN-C-MT	900 h	30 CP	4. semester	All year around	All year around	6 months

1	**Course types** a) Master Thesis b) Colloquium	**Contact time** According to the individual need of the student	**Private study** According to the individual need of the student

2 **Module objectives and skills to be acquired**

Students who successfully completed this module

- have learned to perform scientific work independently and at a demanding level.
- have gained substantial further training in presenting their results to scientific audiences in written and oral form.

are able to defend their scientific achievements and to develop their own ideas within their research fields.

3 **Module content**

The detailed content of the Master Thesis (30 CP) is proposed by the supervising tutor on an individual basis in agreement with the student and has to be approved by the M.Sc. Chemistry Examination Committee. The Master Thesis may be supervised by any member of staff qualified under the University Regulation § 65 HG.

4 **Teaching methods**

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

5 **Prerequisites (for the module)**

Formal requirements: Enrolment in the Master´s degree course “Chemistry”

Additional academic requirements:

Successful completion of one A module, the Scientific Literacy module, one Subject Module, and overall 72 credit points obtained. Written permission by the M.Sc. Chemistry examination committee before start of the module.

For the colloquium: Successful completion of the Master Thesis with a grade of at least “sufficient”.

6 **Type of examination:**

The final examination consists of two parts: Master Thesis and final colloquium of the Master Thesis. The written thesis will be graded by two examiners and their grades combined 1:1. The final grade is determined from the grades for the master's thesis and the final colloquium in the ratio 2:1.

Examination restrictions: 2

7 **Credits awarded**

Each examination part at least “sufficient”.

8	**Compatibility with other curricula** Specific to the Master of Chemistry
9	**Proportion of final grade** 25% (30/120)
10	**Module coordinator** Head of the M.Sc. Chemistry Degree Committee
11	**Further information** Final Specialization Module of the Master's degree course "Chemistry" • In case a student cannot find a supervisor for this module, it is the responsibility of the M.Sc. Chemistry Examination Committee to arrange for one. • The topic of a Master Thesis may be changed once and within the first four weeks. • In special circumstances the M.Sc. Chemistry Examination Committee may prolong the duration of a Master Thesis by four weeks.

3 Study help

3.1 Mentoring System

In order to support the choice of modules in an advisory capacity, each student is assigned a professor as a mentor. This assignment, which is made in the first semester, can be changed by the student upon informal application if no examination results have yet been achieved in this module combination. The mentor's main task is to provide individual advice during the course of study. The student can coordinate the choice of subjects for the respective semesters with this contact person before the semester begins. On the one hand, this is to ensure that the specific modules and choice of subjects correspond to the student's long-term goals and inclinations.

3.2 Sample Study Plans

Start of studies in the winter or summer term:

Term	Module	Number of Exam Elements Type of Exam	CP	Exam restrictions
1	Scientific Literacy	1, oral examination	9	3
	Advanced Chemistry Module 1	1, written examination	6	3
	Advanced Chemistry Module 2	1, written examination	6	3
	Research Topic 1	1, oral examination	6	-
2	Research Topic 2	1, oral examination	6	-
	Subject Module 1	1, oral examination	12	-
	Subject Module 2	1, oral examination	12	-
3	Laboratory Project 1	1, poster presentation and oral defense	15	-
	Laboratory Project 2	1, research proposal and seminar presentation	18	-
4	Master Thesis & Defense	2, master thesis and colloquium	30	2
	Total number of modules: 10	Total number of elements: 9 (excluding master thesis and colloquium)	Total CP number = 120	

3.3 Exam Advice

The chairperson of the examination board, his or her deputy, the head of the respective examination office and his or her deputy can provide legally binding information on examination requirements and performance. The academic advising is carried out by the academic advisors of the Department of Chemistry and by the university lecturers as well as the academic staff who are involved in the training in this study program during office hours. The office hours are posted in the institutes and on the Internet. It is recommended that you make use of an individual course counseling service.

3.4 Further Counselling Offers

The Central Student Advisory Service of the University of Cologne (Zentrale Studienberatung der Universität zu Köln) is available for general study advice, in particular about study options and study requirements. Faculty-wide advisory services are available for interdisciplinary study advice. The General Student Committee (Allgemeine Studierendenausschuss, AStA) and the Chemistry Department and the Biology Department offer advice on general issues relating to study organization. The International Office of the University of Cologne (Akademisches Auslandsamt der Universität zu Köln) and the Center for International Relations (Zentrum für internationale Beziehungen, ZiB) of the Faculty of Mathematics and Natural Sciences offer advice for special questions from foreign students and for preparing for a study abroad. In the case of study-related personal difficulties, the psycho-social counseling of the Kölner Studentenwerk can be used. Students with special study requirements can take advice from the university administration (Department 23: Special Study Matters) and the Rector's representative for the needs of students with disabilities and chronic illnesses.