JACOBS
UNIVERSITY

Study Program Handbook

# Chemistry

Bachelor of Science

## Subject-specific Examination Regulations for Chemistry (Fachspezifische Prüfungsordnung)

The subject-specific examination regulations for Chemistry are defined by this program handbook and are valid only in combination with the General Examination Regulations for Undergraduate degree programs (General Examination Regulations = Rahmenprüfungsordnung). This handbook also contains the program-specific Mandatory Module and Examination Plans (Appendix 1a / 1b).

Upon graduation, students in this program will receive a Bachelor of Science (BSc) degree with a scope of 180 ECTS (for specifics see chapter 3 of this handbook).

| Version | Valid as of | Decision | Details |
|---|---|---|---|
| Fall 2016 - V1 | 01.09.16 | AB August 2016 | Master Version |
| Fall 2016 - V2 | 01.09.17 | AB August 17 | 2.2 revised, 2.5 added |
| Fall 2016 - V3 | 01.09.18 | Academic Senate August 29, 2018 | Figure 3 updated |

# Contents

# 1 The Chemistry Study Program

## 1.1 Concept

Chemistry relates to nearly every aspect of our lives. It lies at the heart of some of worlds most advanced industries, for example those focusing on pharmaceuticals, sustainable energy development, or even the food and beverage industry. The transdisciplinary Bachelor degree in Chemistry offers modules that include courses in nanomolecular science, organic, inorganic, analytical, and physical chemistry; where students are also taught the relevant aspects of mathematics, engineering, and industrial priorities. Over the course of the three-year study program you will take extensive laboratory courses and conduct your own research projects during your third year of study. Undergraduate students are also strongly encouraged to engage in research projects with graduate students as early as their first or second semester at Jacobs University

## 1.2 Specific Advantages of the Chemistry Program at Jacobs University

- Chemistry at Jacobs University combines the long tradition of a thorough education in Chemistry with the opportunity to participate in research projects already at a very early stage of the studies.

- The first year lays the foundation in chemistry, the other natural sciences, and mathematics. The second year focuses on the core education in Organic, Inorganic, and Physical Chemistry. Lectures and exercises furnish theoretical knowledge, while extensive laboratory modules put in place the required practical skills. During the third year, the students carry out their own guided research project in the laboratory of a faculty member in Chemistry.

- Chemistry at Jacobs University provides a stimulating study environment. As classes are small, there is good and supportive interaction of the Chemistry Faculty with the students, with regular contact and support in theoretical questions, research, and the development of written and oral communication skills. Undergraduate students are encouraged, at an early stage, to get involved in a research project that allows close interaction with M.Sc. and Ph.D. students.

- Chemistry at Jacobs University offers a challenging learning environment with maximum flexibility. These unique features combine to make our graduates very attractive to employers as well as graduate schools.

## 1.3 Program-Specific Qualification Aims

- Students will have a thorough knowledge in all core fields of chemistry (inorganic chemistry, organic chemistry, physical chemistry, analytical chemistry) and in bioorganic and supramolecular chemistry.

- Students will receive training in searching all data banks (spectra, reactions, literature) relevant for chemistry.

- Students will be trained in oral and written communications and presentations.

- Students will, through extensive laboratory experience in courses and in research laboratories, as well as hands-on experience with all relevant analytical tools, be able to pursue careers in industry, as well as having optimal preparation for Master of Science and PhD programs.

## 1.4 The Jacobs University Employability and Personal Development Concept

Jacobs University's educational concept aims at fostering employability which refers to skills, capacities, and competencies which transcend disciplinary knowledge and allow graduates to quickly adapt to professional contexts. Jacobs University defines employability as encompassing not just technical skills and understanding but also personal attributes and qualities enabling students to become responsible members of their professional and academic fields as well as of the societies they live in.

Graduates of JU will be equipped with the ability to find employment and to pursue a successful professional career, which means that

- graduates possess the ability to acquire knowledge rapidly, to assess information and to evaluate new concepts critically;

- graduates have communicative competences which allow them to present themselves and their ideas and to negotiate successfully;

- graduates are familiar with business-related processes and management skills and are able to manage projects efficiently and independently.

Graduates of JU will also be equipped with a foundation to become globally responsible citizens, which includes the following attributes and qualities:

- graduates have gained intercultural competence; they are aware of intercultural differences and possess skills to deal with intercultural challenges; they are familiar with the concept of tolerance;

- graduates can apply problem-solving skills in negotiating and mediating between different points of view;

- graduates can rely on basic civic knowledge and have an understanding for ethical reasoning; students are familiar with the requirements for taking on responsibility.

## 1.5 Career Options

Because Chemistry is the core science relating to nearly every aspect of our lives, career opportunities are diverse and abundant. Career possibilities range from research and development in

the areas of pharmaceuticals, nanotechnology, materials and energy to environmental monitoring and forensic science. Chemists are also successful in other positions such as: production managers, business consultants, medical doctors, patent attorneys, marketers and even politicians!

## 1.6 More Information and Contact

For more information please contact the study program coordinator:

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Wisdom Professor of Chemistry
Email: d.gabel@jacobs-university.de
Telephone: +49 421 200-3585

or visit our program website: http://www.jacobs-university.de/chemistry-program

# 2 The Curricular Structure

## 2.1 General

The undergraduate education at Jacobs University equips students with the key qualifications necessary for a successful academic, as well as professional career. By combining disciplinary depth and transdisciplinary breadth, supplemented by skills education and extracurricular elements, students are prepared to be responsible and successful citizens within the societies they work and live in.

The curricular structure provides multiple elements enhancing employability, transdisciplinarity, and internationality. The unique Jacobs Track, offered across all study programs, provides a broad range of tailor-made courses designed to foster career competencies. These include courses which promote communication, technology, business, (German) language, and management skills. The World Track, included in the third year of study, provides extended company internships or study abroad options. Thus students gain training on the job and intercultural experiences.

All undergraduate programs at Jacobs University are based on a coherently modularized structure, which provides students with a broad and flexible choice of study plans to meet their major as well as minor study interests.
The policies and procedures regulating undergraduate study programs at Jacobs University in general can be found on the website.

## 2.2 The Jacobs University 3C-Model

Jacobs University offers study programs according to the regulations of the European Higher Education Area. All study programs are structured along the European Credit Transfer System (ECTS), which facilitates credit transfer between academic institutions. The three-year undergraduate program involves six semesters of study with a total of 180 ECTS credits. The curricular structure follows an innovative and student-centered modularization scheme - the 3C-Model - which groups the disciplinary content of the three study years according to overarching themes:

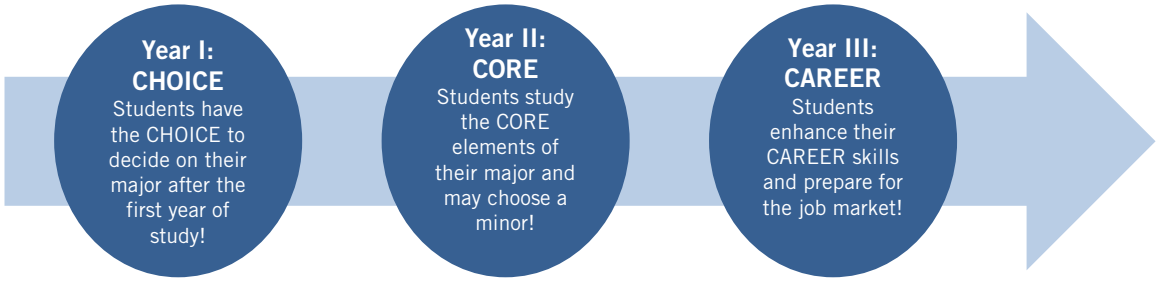



Figure 1: The Jacobs University 3C-Model

### 2.2.1 YEAR 1 - CHOICE

The first study year is characterized by a broad offer in disciplinary and interdisciplinary education. Students select three CHOICE modules from a variety of study programs. As a unique asset, our curricula allow students to select their study program freely from among the three selected CHOICE modules during their first year of study.

### 2.2.2 YEAR 2 - CORE

In the second year, students take three in-depth, discipline-specific CORE modules. One CORE module can also be taken from a second, complementary discipline, which allows students to incorporate a minor study track into their undergraduate education. Students will generally qualify for a minor if they have successfully taken at least one CHOICE module and one CORE module in a second field, and this extra qualification will be highlighted in the transcript.

### 2.2.3 YEAR 3 - CAREER

During their third year, students must decide on their career after graduation. In order to facilitate this decision, the fifth semester introduces two separate tracks. By default students are registered for the World Track.

1. **The World Track**
   In this track there are two mandatory elective options:
   - **Internship**
     The internship program is a core element of Jacobs University's employability approach. It includes a mandatory semester-long internship off-campus (minimum 16 weeks in full-time) which provides insight into the labor market as well as practical work experience related to the respective area of study. Successful internships may initiate career opportunities for students. For more information, please contact the Career Services Center (http://www.jacobs- university.de/career-services/contact).
   - **Study Abroad**
     Students can take the opportunity to study abroad at one of our partner universities. Courses recognized as study abroad credits need to be pre-approved according to the Jacobs University study abroad procedures and carry minimum of 20 ECTS credits in total. Several exchange programs allow you to be directly enrolled at prestigious partner institutions worldwide. Jacobs University's participation in Erasmus+, the European Unions exchange program, provides an exchange semester at a number of European universities including Erasmus study abroad funding. For more information, please contact the International Office (http://intoffice.user.jacobs-university.de/outgoing/).
2. **The Campus Track**
   Alternatively, students may also opt to follow the Campus Track by continuing their undergraduate education at Jacobs, namely by selecting an additional CORE module during their third year and redistributing the remaining courses and modules across the third year. This opportunity can be used by students to more intensively focus on their major or to fulfill the minor requirements for a second field of interest.

In the sixth semester, all students select from a range of specialization courses within their study program and concentrate on their Bachelor thesis in the context of a Project/Thesis Module.

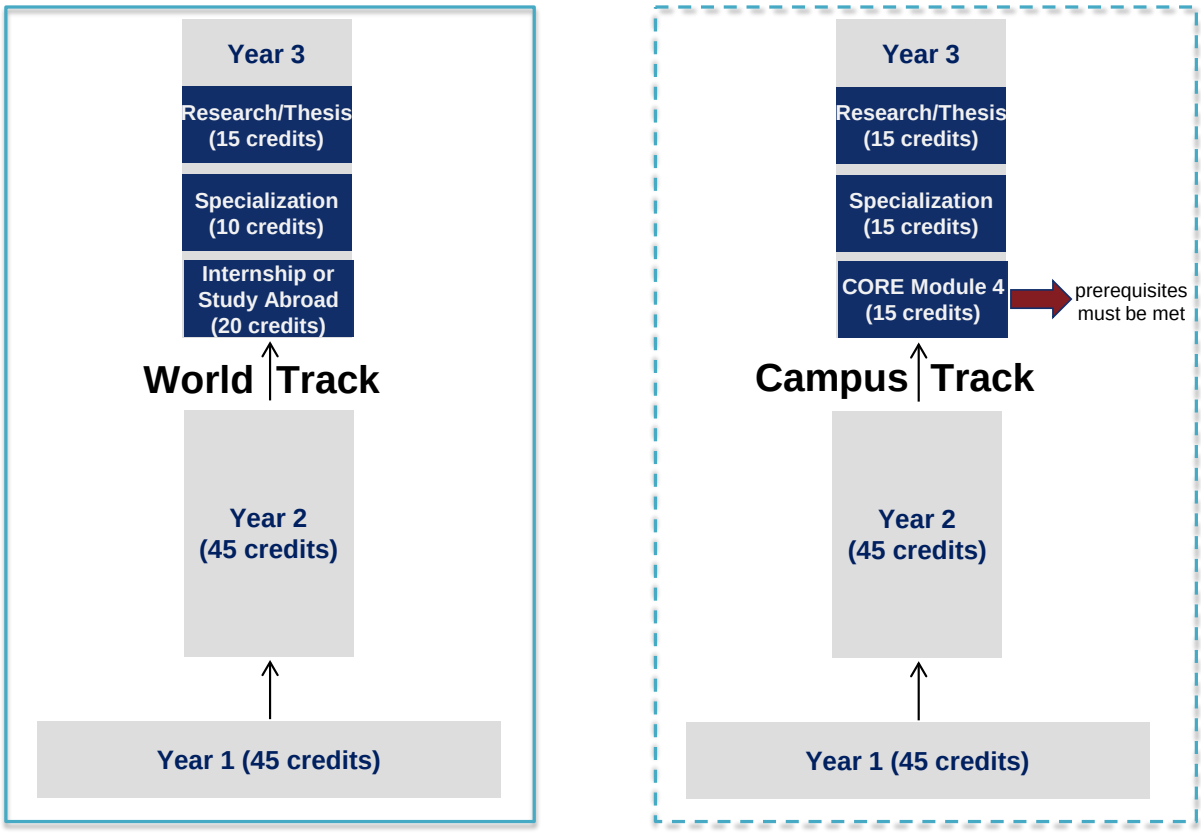



Figure 2: World Track versus Campus Track

**Career Skills**

Throughout their studies all students attend a mandatory set of career skills courses and events.

The mandatory Career Skills module prepares all undergraduate students at Jacobs University for the transition from student life to working life as well as for their future career. Skills, knowledge and information which are fundamental for participation in an internship or a semester abroad will be conveyed concurrently. Essential components of the module include information sessions, compulsory seminars on various career-relevant topics as well as participation in the annual Jacobs Career Fair.

The successful completion of the Career Skills Module and the encompassed single seminars are graded with Pass/Fail for all students. ECTS credits are not awarded. All undergraduate students will be automatically registered for the Career Skills Module. However, every student has to keep track of his/her individual fulfillment of requirements and has to register on Campusnet for all seminars and sessions during the official registration period at the beginning of each semester. An overview of the sequence in which components should be completed is shown in the table below:

**CAREER SKILLS MODULE** For Undergraduate Students matriculated Fall 2015 and Fall 2016

| SEMESTER | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| MANDATORY BASICS | CSC-INFO<br>Session: "CSC Services"<br>CA01-990000 | | CSC-INFO<br>Session: "World Track"<br>CA01-990026 | | | |
| MANDATORY SEMINARS | Both seminars have to be attended in your first or second semester:<br>CSC-APPLICATION TRAINING<br>CA01-990001<br>CSC-RESEARCHING & CONTACTING EMPLOYERS<br>CA01-990004 | | | | | |
| MANDATORY ELECTIVE SEMINARS (seminar program subject to availability) | | | Attend 2 out of several career skills seminars and workshops.<br>i.e.<br>▪ Business Etiquette ▪ Presentation Skills<br>▪ Communication Skills ▪ Grad School Application Training ▪ Self-Management ▪ Time-Management<br>▪ Decision Making ▪ Preparing for an Interview<br>▪ Introduction to Project Management | | | |
| OTHER MANDATORY COMPONENTS | | | | CSC-JACOBS CAREER FAIR<br>in February, on campus<br>CA01-990003 | INTERNSHIP<br>or<br>STUDY ABROAD<br>or<br>CAMPUS TRACK | INTERNSHIP & STUDY ABROAD EVENT<br>Online<br>CSC-CAREER SURVEY<br>CA01-990002 |

Figure 3: The Career Skills Module

## 2.3 The Jacobs Track

The Jacobs Track, another stand-alone feature of Jacobs University, runs parallel to the disciplinary CHOICE, CORE, and CAREER modules across all study years and is an integral part of all study programs. It reflects our commitment to an in-depth methodological education, it fosters our transdisciplinary approach, it enhances employability, and equips students with extra skills desirable in your general field of study. Additionally, it integrates essential language courses.

Mathematics, statistics, and other methods courses are offered to all students within a comprehensive Methods Module. This module provides students with general foundations and transferable techniques which are invaluable to follow the study content not only in the study program itself but also in related fields.

The Skills Module equips students with general academic skills which are indispensable for their chosen area of study. These could be, for example, programming, data handling, presentation skills, and academic writing, scientific and experimental skills.

The transdisciplinary Triangle Module offers courses with a focus on at least one of the areas of business, technology and innovation, and societal context. The offerings comprise essential knowledge of these fields for students from other majors as well as problem-based courses that tackle global challenges from different disciplinary backgrounds. Working together with students from different disciplines and cultural backgrounds in these courses broadens the students horizon by crossing the boundaries of traditional disciplines.

Foreign languages are integrated within the Language Module. Communicative skills and foreign language competence foster students intercultural awareness and enhance their employability in a globalized and interconnected world. Jacobs University supports its students in acquiring and improving these skills by offering a variety of language courses at all proficiency levels. Emphasis is put on fostering German language skills, as they are an important prerequisite for students to learn about, explore, and eventually integrate into their host country. Hence, acquiring 10 ECTS credits in German is a requirement for all students. Students who meet the requirements of the German proficiency level (e.g. native speakers) are required to select courses in any other language program offered.

## 2.4 Modularization of the Chemistry Program

### 2.4.1 Content

**Year 1**
Take two mandatory modules listed below and select one further CHOICE module from a different study area.

**Organic Chemistry (CH03-OrgChem)**
We begin by reestablishing atomic structure, and the importance of Lewis dot structures, resonance, valence-shell electron-pair repulsion, and valence-bond theory to give meaning to a covalent bond. Hybridization is then introduced to allow an accurate and predictive accounting of molecular shape. This foundation permits the introduction of: functional groups, conformation, chirality, acidity and basicity, and the basics of equilibria, thermodynamic, and kinetic phenomena. With these concepts in hand, we develop organic reactivity by examining the mechanistic pathways (arrow pushing) and chemical principles behind substitution, elimination, and addition reactions. Common reagents and functional group transformations are then learned in the context of the importance of their order and type (retrosynthetic analysis and strategy) for brevity in synthesis.

**Inorganic Chemistry and Environmental Systems (CH04-InorgChem)**
The bifunctional module Chemistry and Environmental Systems provides an introduction to (inorganic) chemistry and to the anthropogenic impact on the natural (near-)surface environment of Earth. Two introductory lecture courses (Introduction to Inorganic Chemistry (focus on the elements of the PSE, molecular compounds derived from them, redox reactions) and Earth and Environmental Systems (focus on Geodynamics, Petrography, Soil Science, Oceanography, Hydrogeology, Geomorphology, and anthropogenic impact on the (near-)surface environment) are complemented by an on-campus laboratory course (Inorganic Chemistry Lab) and an off-campus field-lab (excursion) to develop fundamental practical skills.

**Year 2**
Take all three modules or replace one with a CORE module from a different study program.

**Chemical Biotechnology (CO07-ChemBiotec)**
This module provides insight into how biotechnology impacts chemical production. The replacement of both chemical catalysts by enzymes and cells and of fossil resources by renewable raw materials are two aspects which are increasingly pushed by the chemical industry in order to achieve a more sustainable production of bulk and ?ne chemicals, building blocks for chemical industry as well as food ingredients, bioplastics, and biofuels. Using a number of commercially successful examples as well as current R&D efforts of chemical industry, the students will be introduced into the advantages and practice of implementing cells or enzymes for the production of industrially relevant products. Moreover, the module describes the utilization of biomass and biomass waste streams as feedstock for production of the above mentioned compounds. The concept of biorefinery is also discussed.

**Physical and Analytical Chemistry (CO08-PhysChem**
Teaching physical principles and measurements to understand the properties of matter. The

course Physical Chemistry introduces fundamental themodynamical principles, intermolecular forces, electrochemistry as well as underlying physical principle of chemical kinetics. The students will apply the course content to experiments on osmotic pressure, electrochemistry and optical instrumentation. The analytical chemistry part will provide an overview over the physical principles of spectroscopic and separation methods and their application in quantitative and qualitative analysis.

**Materials Chemistry (CO09-CoChem)**
The module gives information about inorganic materials and polymers, and about organic materials and polymers. Coordination compounds as basis of inorganic materials will be discussed. Methods for structure elucidation of polymeric and solid materials will be presented. Basic reactions to form these materials will be given. Industrially important materials and their preparation will be discussed. Examples of non-covalent interactions as basis for supramolecular chemistry are shown, and sensors based on the different technologies will be discussed. An introduction into surface and colloid chemistry forms part of the module.
Some CORE Modules require students to have taken a specific CHOICE Module. Please see the Module Handbook for details regarding pre-requisites.

**Year 3**
In the 3rd year students follow the World Track by default:

1. **World Track**
   5th Semester
   - Internship / study abroad

   6th Semester
   - Chemistry Project / Thesis Module
   - Program-specific Specialization Module
     Exemplary course offering:
     - Advanced Synthesis
     - Organometallic Chemistry
     - Methods for Bioconjugation
     - Structure Elucidation of Biomolecules
     - Introduction to Biophysical Chemistry
     - Binding and Enzyme Assays

2. **Campus Track**
   Students who do not enter the World Track follow the Campus Track.
   5th and 6th Semester
   - Program-specific Project / Thesis Module
   - Program-specific Specialization Module
     (please see World Track for exemplary course offering)
   - Additional CORE Module

## 2.5 The Bachelor Thesis / Project

This module is a mandatory graduation requirement for all undergraduate students. It consists of two components in the major study program guided by a Jacobs Faculty member:

1. **A Research Project** (5 ECTS)
   and
2. **The Bachelor Thesis** (10 ECTS)

The workload for the project component is about 125 hours and for the thesis component about 250 hours.The title of the thesis will be shown on the transcript.

### 2.5.1 Aims

Within this module, students apply knowledge they have acquired about their major discipline, skills, and methods to become acquainted with actual research topics, ranging from the identification of suitable (short-term) research projects, preparatory literature searches, the realization of discipline-specific research, and the documentation, discussion, and interpretation of the results. Research results obtained from the Research Project can be embedded in the Bachelor Thesis.

### 2.5.2 Intended Learning Outcomes

1. Research Project
   This module component consists of a guided research project in the major study program. The well-defined research task must be completed and documented according to the scientific standards in the respective discipline. It involves a high degree of independence, supported by individualized instructor feedback and guidance.
2. Bachelor Thesis
   With their Bachelor Thesis students should demonstrate mastery of the contents and methods of the major specific research field. Furthermore, students should show the ability to analyze and solve a well-defined problem with scientific approaches, a critical reflection of the status quo in scientific literature, and an original development of their own ideas.

Both, the Research Project and the Bachelor Thesis, can also have an inter- or transdisciplinary nature - with the explicit permission of the supervisor.

### 2.5.3 Supervision

Both module components can be performed with the same Jacobs faculty member, or different ones, the latter in order to allow a broader research experience. Students are required to choose a supervisor, at the latest, by the end of the drop-add period of the semester in which the module component is taken. **The selected supervisor(s) must approve the Project topic and Bachelor Thesis topic before the student starts to work towards the module component.** The respective study program coordinators will assist in the search for prospective supervisor(s).

### 2.5.4 Registration

**World Track students** register for both components, at the earliest, in their 6th semester.
**Campus Track students** register for the Project component in the 5th and for the Bachelor Thesis component, at the earliest, in their 6th semester.

The registrations must be made before the end of the respective drop/add periods.

Later enrolment is possible for those students pursuing a second major or those who graduate late for other reasons. These students perform their (second) thesis earliest in the 7th semester of their studies. They have to contact the Student Records Office for individual registration.

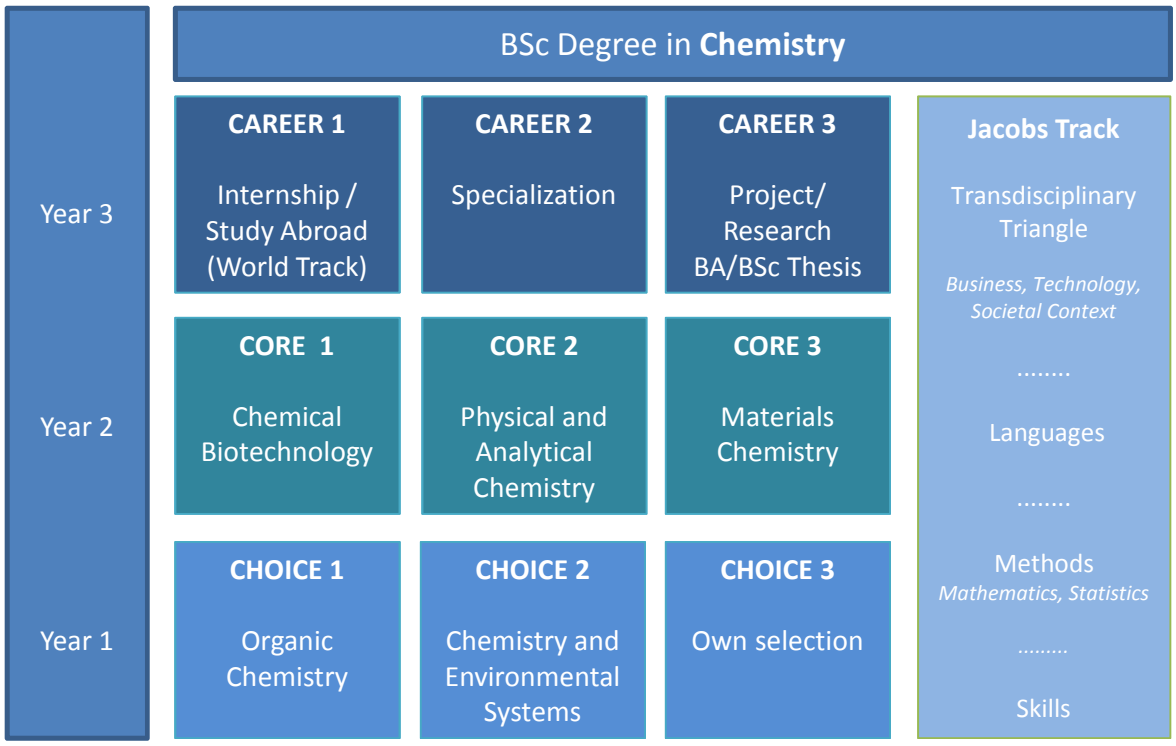
Students are allowed to extend their thesis related work into the intersession or summer break upon approval of the thesis supervisor and Student Records. Students are not allowed to register for different Bachelor Thesis courses in the same semester.

### 2.5.5 Formal Regulations for the Bachelor Thesis

- Timing
  The Thesis work has to be generated within the semester of registration. The semester period has 14 weeks.
- Extent
  The document must be between 15-25 pages in length, including references, but excluding appendices or supporting information. Deviations in length and format can be determined within individual study programs and should be communicated to all registered students by the study program coordinator.
- Cover page
  The cover page must show the title of the Bachelor Thesis, the university's name, the month and year of submission, the name of the student and the name of the supervisor.
- Statutory Declaration
  Each Bachelor Thesis must include a statutory declaration signed by the student confirming it is their own independent work and that it has not been submitted elsewhere. The respective form can be found on the Student Records Office website.
- Submission
  The Bachelor Thesis must be submitted as a hard copy (pdf-file) to the supervisor and additionally to the Student Records Office via online form on the Student Records Office website.

  **Deadline for submission of the Bachelor Thesis is May 15 (unless specified otherwise by the Student Records Office).**

### 2.5.6 Structure




*YEAR 1* *Take three CHOICE modules, one free selection*
*YEAR 2* *Take three CORE modules, one CORE module can be substituted by a CORE module from a second study program to pursue a minor*
*YEAR 3* *Alternatively Campus Track with a 4th CORE module instead of internship/study abroad module*

Figure 4: Chemistry Module Structure

# 3 Appendix 1a/1b: Mandatory Module and Examination Plans for World Track and Campus Track

Jacobs University Bremen reserves the right to substitute courses by replacements and/or reduce the number of mandatory/mandatory elective courses offered.

# 4 Appendix 2: Course Data for Program-Specific CHOICE and CORE Courses

All course data stated in the appendix is based on the previous study year and subject to change.

# Appendix 1a - Mandatory Module and Examination Plan for World Track

JACOBS UNIVERSITY

## Chemistry – World Track

**Matriculation Fall 2016**

| | Program-Specific Modules | Type | Status[1] | Semester | Credits | | Jacobs Track Modules (General Education) | Type | Status[1] | Semester | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year 1 - CHOICE** | | | | | **45** | | | | | | **20** |
| *Take the two mandatory CHOICE modules listed below, these are a requirement for the Chemistry program.* | | | | | | | | | | | |
| **CH03-OrgChem** | **Module: Organic Chemistry** | | **m** | | **15** | | **JT-ME-MethodsMath** | **Module: Methods / Mathematics** | | **m** | | **7,5** |
| CH03-400102 | Organic Chemistry I | Lecture | m | 1 | 5 | | JT-ME 120106 / 120103 | Take either Applied Calculus I or Calculus I | Lecture | m | 1 | 2,5 |
| CH03-400112 | Organic Chemistry I Lab | Lab | m | 1 | 2,5 | | JT-ME 120107 / 120104 | Take either Applied Calculus II or Calculus II | Lecture | m | 1 | 2,5 |
| CH03-400103 | Organic Chemistry II | Lecture | m | 2 | 5 | | JT-ME-120101 | Mathematical Concepts in the Sciences | Lecture | m | 2 | 2,5 |
| CH03-400113 | Organic Chemistry II Lab | Lab | m | 2 | 2,5 | | **JT-SK-Skills** | **Module: Skills** | | **m** | | **2,5** |
| **CH04-InorgChem** | **Module: Inorganic Chemistry and Environmental Systems** | | **m** | | **15** | | JT-SK-990103 | Scientific and Experimental Skills | Lecture | m | 1 | 2,5 |
| CH04-210113 | Introduction to Inorganic Chemistry and Earth & Environmental Syste | Lecture | m | 1 | 5 | | **JT-TA-TriArea** | **Module: Triangle Area** | | **m** | | **5** |
| CH04-400111 | Inorganic Chemistry I Lab | Lab | m | 1 | 2,5 | | | Take two courses from the triangle (BUSINESS, TECHNOLOGY & | | me | 1/2 | 5 |
| CH04-210114 | Advanced Earth & Environmental Systems and Inorganic Chemistry | Lecture | m | 2 | 5 | | | INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3] | | | | |
| CH04-210111 | GeoEnvironmental Systems and their Chemistry - Field Lab | Excursion | m | 2 | 2,5 | | **JT-LA-Language** | **Module: Language** | | **m** | | **5** |
| | **Module: CHOICE (own selection)** | | **e** | **1/2** | **15** | | | Take two German courses (2,5 ECTS each). | Seminar | me | 1/2 | 5 |
| Students take one further CHOICE module from those offered for all other study programs. [2] | | | | | | | | Native German speakers take courses in another offered language | | | | |
| **Year 2 - CORE** | | | | | **45** | | | | | | **20** |
| *Take all three modules or replace one with a CORE module from a different study program.* [2] | | | | | | | | | | | |
| **CO09-InorgSuMolChe** | **Module: Inorganic and Supramolecular Chemistry** | | **me** | | **15** | | **JT-ME-MethodsMath** | **Module: Methods / Mathematics** | | **m** | | **7,5** |
| CO09-420432 | Supramolecular Chemistry | Lecture | m | 3 | 5 | | JT-ME-120122 | Foundations of Linear Algebra I | Lecture | m | 4 | 2,5 |
| CO09-420434 | Supramolecular Chemistry Lab | Lab | m | 4 | 2,5 | | | Take two Methods (mandatory) elective courses. (2,5 ECTS each). [2] | Lecture | me | 3/4 | 5 |
| CO09-400221 | Inorganic Chemistry II | Lecture | m | 4 | 5 | | | | | | | |
| CO09-400232 | Inorganic Chemistry II Lab | Lab | m | 4 | 2,5 | | | | | | | |
| **CO08-PhysChem** | **Module: Physical and Analytical Chemistry** | | **me** | | **15** | | **JT-TA-TriArea** | **Module: Triangle Area** | | **m** | | **7,5** |
| CO08-400121 | Analytical Chemistry | Lecture | m | 3 | 5 | | | Take three courses from the triangle (BUSINESS, TECHNOLOGY & | | me | 3/4 | 7,5 |
| CO08-400231 | Analytical Chemistry Lab | Lab | m | 4 | 2,5 | | | INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3] | | | | |
| CO08-400211 | Physical Chemistry | Lecture | m | 4 | 5 | | | | | | | |
| CO08-400262 | Physical Chemistry Lab | Lab | m | 4 | 2,5 | | | | | | | |
| **CO07-ChemBiotec** | **Module: Chemical Biotechnology** | | **me** | | **15** | | **JT-LA-Language** | **Module: Language** | | **m** | | **5** |
| CO07-400104 | Enzymes and Cells in Biochemical Production | Lecture | m | 3 | 5 | | | Take two German courses (2,5 ECTS each). | Seminar | me | 3/4 | 5 |
| CO07-400114 | Biochemical Production Lab | Lab | m | 3 | 2,5 | | | Native German speakers take courses in another offered language | | | | |
| CO07-400105 | Bioproducts and Biosystems Engineering | Lecture | m | 4 | 5 | | | | | | | |
| CO07-400115 | Bioproducts and Biosystems Engineering Lab | Lab | m | 3 | 2,5 | | | | | | | |
| **Year 3 - CAREER** | | | | | **45** | | | | | | | **5** |
| **CA02 / CA03** | **Module: Internship / Study Abroad** | | **m** | **5** | **20** | | **JT-SK-Skills** | **Module: Skills** | | **m** | | **2,5** |
| **CA01-CarSkills** | **Module: Career Skills** | | **m** | | | | JT-SK-990104 | Advanced Scientific and Experimental Skills | Lecture | m | 6 | 2,5 |
| **CA06-CHEM** | **Module: Project/Thesis CHEM** | | **m** | | **15** | | **JT-TA-TriArea** | **Module: Triangle Area** | | **m** | | **2,5** |
| CA06-400303 | Project CHEM | | m | 6 | 5 | | | Take one course from the triangle (BUSINESS, TECHNOLOGY & | | me | 6 | 2,5 |
| CA06-400304 | Thesis CHEM | | m | 6 | 10 | | | INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3] | | | | |
| **CAS-WT-CHEM** | **Module: Specialization Area CHEM** | | **m** | | **10** | | | | | | | |
| | Take four specialization courses (2.5 ECTS each) [2] | | me | 5/6 | 10 | | | | | | | |
| **Total ECTS** | | | | | | | | | | | | **180** |

[1] Status (m = mandatory, e = elective, me = mandatory elective)

[2] For a full listing of all CHOICE / CORE / CAREER / Jacobs Track modules please consult the **CampusNet online catalogue** and / or the module handbook (on our website).

[3] You are required to take six Triangle Area courses in total. Select two from each of the three triangle areas (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT).

# Appendix 1b - Mandatory Module and Examination Plan for Campus Track

## Chemistry – Campus Track

**Matriculation Fall 2016**

| | Program-Specific Modules | Type | Status[1] | Semester | Credits | | | Jacobs Track Modules (General Education) | Type | Status[1] | Semester | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year 1 - CHOICE** | | | | | **45** | | | | | | | **20** |
| *Take the two mandatory CHOICE modules listed below, these are a requirement for the Chemistry program.* | | | | | | | | | | | | |
| **CH03-OrgChem** | **Module: Organic Chemistry** | | **m** | | **15** | | | **JT-ME-MethodsMath** | **Module: Methods / Mathematics** | | **m** | | **7,5** |
| CH03-400102 | Organic Chemistry I | Lecture | m | 1 | 5 | | | JT-ME 120106 / 120103 | Take either Applied Calculus I or Calculus I | Lecture | m | 1 | 2,5 |
| CH03-400112 | Organic Chemistry I Lab | Lab | m | 1 | 2,5 | | | JT-ME 120107 / 120104 | Take either Applied Calculus II or Calculus II | Lecture | m | 1 | 2,5 |
| CH03-400103 | Organic Chemistry II | Lecture | m | 2 | 5 | | | JT-ME-120101 | Mathematical Concepts in the Sciences | Lecture | m | 2 | 2,5 |
| CH03-400113 | Organic Chemistry II Lab | Lab | m | 2 | 2,5 | | | **JT-SK-Skills** | **Module: Skills** | | **m** | | **2,5** |
| **CH04-InorgChem** | **Module: Inorganic Chemistry and Environmental Systems** | | **m** | | **15** | | | JT-SK-990103 | Scientific and Experimental Skills | Lecture | m | 1 | 2,5 |
| CH04-210113 | Introduction to Inorganic Chemistry and Earth & Environmental Syste | Lecture | m | 1 | 5 | | | **JT-TA-TriArea** | **Module: Triangle Area** | | **m** | | **5** |
| CH04-400111 | Inorganic Chemistry I Lab | Lab | m | 1 | 2,5 | | | | Take two courses from the triangle (BUSINESS, TECHNOLOGY & | | me | 1/2 | 5 |
| CH04-210114 | Advanced Earth & Environmental Systems and Inorganic Chemistry | Lecture | m | 2 | 5 | | | | INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3] | | | | |
| CH04-210111 | GeoEnvironmental Systems and their Chemistry - Field Lab | Excursion | m | 2 | 2,5 | | | **JT-LA-Language** | **Module: Language** | | **m** | | **5** |
| | **Module: CHOICE (own selection)** | | **e** | **1/2** | **15** | | | | Take two German courses (2,5 ECTS each). | Seminar | me | 1/2 | 5 |
| Students take one further CHOICE module from those offered for all other study programs. [2] | | | | | | | | | Native German speakers take courses in another offered language | | | | |
| **Year 2 - CORE** | | | | | **45** | | | | | | | **20** |
| *Take all three modules or replace one with a CORE module from a different study program.* [2] | | | | | | | | | | | | |
| **CO09-InorgSuMolChe** | **Module: Inorganic and Supramolecular Chemistry** | | **me** | | **15** | | | **JT-ME-MethodsMath** | **Module: Methods / Mathematics** | | **m** | | **7,5** |
| CO09-420432 | Supramolecular Chemistry | Lecture | m | 3 | 5 | | | JT-ME-120122 | Foundations of Linear Algebra I | Lecture | m | 4 | 2,5 |
| CO09-420434 | Supramolecular Chemistry Lab | Lab | m | 4 | 2,5 | | | | Take two Methods (mandatory) elective courses. (2,5 ECTS each). [2] | Lecture | me | 3/4 | 5 |
| CO09-400221 | Inorganic Chemistry II | Lecture | m | 4 | 5 | | | | | | | | |
| CO09-400232 | Inorganic Chemistry II Lab | Lab | m | 4 | 2,5 | | | | | | | | |
| **CO08-PhysChem** | **Module: Physical and Analytical Chemistry** | | **me** | | **15** | | | **JT-TA-TriArea** | **Module: Triangle Area** | | **m** | | **7,5** |
| CO08-400121 | Analytical Chemistry | Lecture | m | 3 | 5 | | | | Take three courses from the triangle (BUSINESS, TECHNOLOGY & | | me | 3/4 | 7,5 |
| CO08-400231 | Analytical Chemistry Lab | Lab | m | 4 | 2,5 | | | | INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3] | | | | |
| CO08-400211 | Physical Chemistry | Lecture | m | 4 | 5 | | | | | | | | |
| CO08-400262 | Physical Chemistry Lab | Lab | m | 4 | 2,5 | | | | | | | | |
| **CO07-ChemBiotec** | **Module: Chemical Biotechnology** | | **me** | | **15** | | | **JT-LA-Language** | **Module: Language** | | **m** | | **5** |
| CO07-400104 | Enzymes and Cells in Biochemical Production | Lecture | m | 3 | 5 | | | | Take two German courses (2,5 ECTS each). | Seminar | me | 3/4 | 5 |
| CO07-400114 | Biochemical Production Lab | Lab | m | 3 | 2,5 | | | | Native German speakers take courses in another offered language | | | | |
| CO07-400105 | Bioproducts and Biosystems Engineering | Lecture | m | 4 | 5 | | | | | | | | |
| CO07-400115 | Bioproducts and Biosystems Engineering Lab | Lab | m | 3 | 2,5 | | | | | | | | |
| **Year 3 - CAREER** | | | | | **45** | | | | | | | **5** |
| **COXX** | **Module: Additional (4th) CORE module** | | **m** | **5/6** | **15** | | | **JT-SK-Skills** | **Module: Skills** | | **m** | | **2,5** |
| **CA01-CarSkills** | **Module: Career Skills** | | **m** | | | | | JT-SK-990104 | Advanced Scientific and Experimental Skills | Lecture | m | 6 | 2,5 |
| **CA06-CHEM** | **Module: Project/Thesis CHEM** | | **m** | | **15** | | | **JT-TA-TriArea** | **Module: Triangle Area** | | **m** | | **2,5** |
| CA06-400303 | Project CHEM | | m | 6 | 5 | | | | Take one course from the triangle (BUSINESS, TECHNOLOGY & | | me | 5 | 2,5 |
| CA06-400304 | Thesis CHEM | | m | 6 | 10 | | | | INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3] | | | | |
| **CAS-CT-CHEM** | **Module: Specialization Area CHEM** | | **m** | | **15** | | | | | | | | |
| | Take **six** specialization courses (2.5 ECTS each) [2] | | me | 5/6 | 15 | | | | | | | | |
| **Total ECTS** | | | | | | | | | | | | | **180** |

[1] Status (m = mandatory, e = elective, me = mandatory elective)

[2] For a full listing of all CHOICE / CORE / CAREER / Jacobs Track modules please consult the **CampusNet online catalogue** and / or the module handbook (on our website).

[3] You are required to take six Triangle Area courses in total. Select two from each of the three triangle areas (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT).

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Organic Chemistry I | CH03-400102 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CH03-OrgChem Organic Chemistry | 125 | Bachelor 1st Year CHOICE |

***Course Description / Content / Aims***

The course begins by establishing a strong working knowledge of atomic, hybridized, and molecular orbitals. This is vital for our understanding of the next material: Lewis dot structures, octet rule, electron ownership, resonance, bond angles, bond strength, bond order, molecular shape, conformation, transition states, and pKa (acidity/basicity). Functional groups (halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides, anhydrides, acetals, etc.), nonmenclature, and chirality (stereogenic centers) are then addressed. This conceptual framework allows reactivity (electrophiles and nucleophiles) to then be discussed in the context of mechanistic pathways (SN1, E1, SN2, and E2) and the law of mass action. Specific functional group interconversions are then addressed beginning with an early discussion of carbonyl reactivity (enolates, imines, enamines, aldol reactions, etc.) to better facilitate our understanding of biochemical reaction pathways.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Final Grade | 100% |

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Organic Chemistry I Lab | CH03-400112 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CH03-OrgChem Organic Chemistry | 62,5 | Bachelor 1st Year CHOICE |

***Course Description / Content / Aims***

A chemical laboratory is a place for exploration, but before that happens we must reinforce important safety aspects, common hazards, and the structure & content requirements of a useful laboratory report. After this, we introduce the essential techniques to: monitor and quench reactions (TLC, color change, neutralizing active chemicals, etc.), purify products (chromatography, crystallization, separatory funnel extractions, etc.), and spectroscopically identify compounds. In parallel, we introduce the equipment (rotary evaporator, melting point apparatus, etc.) and instrumentation (nuclear magnetic resonance (1H and 13C NMR)) to achieve those goals. After mastering these techniques, the next semester (Org Chem II lab) is devoted to the higher level goal of setting up reactions under diverse reaction conditions to produce pure compounds.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Compound Synthesis | 30% |
| General Laboratory Performance | 40% |
| Lab Reports | 30% |

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Organic Chemistry II | CH03-400103 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CH03-OrgChem Organic Chemistry | 125 | Bachelor 1st Year CHOICE |

***Course Description / Content / Aims***

The second semester of Organic Chemistry strongly builds on the concepts and principles introduced during the first semester. During this course a much broader exposure to reagents and reactions (functional group interconversion) is focused on, and this material is learned within the framework of stereocontrol, mechanisms (arrow pushing), and the importance of reaction step order to achieve step efficient synthesis. Exposure to the tactics and strategies of synthesis will provide the context for retrosynthetic analysis, and an appreciation synthesizing challenging drug molecules. Major topics of discussion will be: alkene formation (Wittig reaction) and transformations thereof (bromination, epoxidation, dihydroxylation, Diels-Alder reactions, etc.), aromaticity, Friedel-Crafts alkylation and acylation, benzyne elimination-addition reactions, derivatization and formation of phenols (Meisenheimer complexes - SNAr mechanism), a continued investigation of carbonyl chemistry (aldehyde, ketone, ester, amides, carboxylic acid): formation, reduction, nucleophilic addition to, etc. Amines play a vital role in drug development and their formation and manipulation are discussed. Special topics will be introduced, e.g. amide hydroysis (peptide cleavage) at an oxyanion hole, to show how a living system can accomplish important chemical reactions.

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Organic Chemistry II Lab | CH03-400113 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CH03-OrgChem Organic Chemistry | 62,5 | Bachelor 1st Year CHOICE |

***Course Description / Content / Aims***

A chemical laboratory is a place for exploration, and the second semester organic laboratory places you squarely in that environment. Here you will set up your own reactions, sometimes at low temperature (e.g. -78 oC) and at other times under an inert atmosphere of nitrogen gas to protect your reactions from the negative effects of the moisture present in the air that we breathe. You will also expand your techniques, e.g., employing vacuum distillation, and exposure to instrumentation, e.g., gas and liquid chromatography, infrared spectroscopy (IR), etc. Most importantly, you will begin to appreciate the whole process of designing and then performing a reaction. From the starting reaction table you have built using reaction stoichiometry to determine the weight or volume of the reagents, to the order and timing of reagent additions, all the way to providing a pure chemical in the end whose structure you can rigorously support via multiple pieces of chromatographic and spectroscopic evidence. You will leave this lab having obtained the essence of the art of organic synthesis.

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Introduction to Inorganic Chemistry and Earth and Environmental Sciences | CH04-210113 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CH04-InorgChem Inorganic Chemistry and Environmental Systems | 125 | Bachelor 1st Year CHOICE |

***Course Description / Content / Aims***

[h2]Inorganic Chemistry[/h2]
An introduction to fundamental concepts of general/inorganic chemistry including the following areas: matter, measurements and moles, elements, compounds, units, chemical reactions, stoichiometry, equations, equilibrium, acids and bases, properties of gases.

[h2]Earth & Environmental Sciences[/h2]
Students are introduced to the fundamental principles and concepts in the geosciences, with special emphasis on the Earth's internal structure and on plate tectonics. The focus then shifts towards the "Critical Zone", i.e. on the complex near-surface environment in which interactions between rock, soil, water, air and living organisms define the natural habitat and control the availability of live-sustaining resources. Students will be introduced in a qualitative way to the basic components of and fundamental processes operating in the critical zone.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Attendance - Kortz | 5% |
| Exam 1 - Prof. Kortz | 22% |
| Exam 2 - Prof. Kortz | 23% |
| Final Exam - Prof. Bau | 15% |
| Part Koschinsky | 25% |
| Quizz(es) - Bau | 10% |

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Inorganic Chemistry I Lab | CH04-400111 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CH04-InorgChem Inorganic Chemistry and Environmental Systems | 62,5 | Bachelor 1st Year CHOICE |

***Course Description / Content / Aims***
Foundation principles of chemistry, including basic laboratory techniques, qualitative analysis of anions and cations, strong/weak acids and bases, titrations, solubility of salts, crystallization, redox reactions, gravimetric analysis, volumetric analysis, complex formation, synthesis of nanoparticles.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Lab Performance | 50% |
| Lab Reports | 40% |
| Quizz(es) | 10% |

# Appendix 2 - Course Data

| ***Course Name*** GeoEnvironmental Systems and their Chemistry-Field Lab | ***Course No*** CH04-210111 | ***ECTS*** 2,5 |
|---|---|---|
| ***Module Affiliation*** CH04-InorgChem Inorganic Chemistry and Environmental Systems | ***Workload (hrs / sem)*** 62,5 | ***Level*** Bachelor 1st Year CHOICE |
| ***Course Description / Content / Aims*** Introduction to the fundamental techniques of field geology and field geochemistry including using geology, water chemistry and environmental problems in the old mining district of the Harz Mountains, Germany, as examples. The students participate in a three-day field trip that includes introductory lunchtime lectures prior to the field trip, the three-day field trip itself, and two evening lectures during the field trip. | | |
| | | |
| | | |
| ***Course Name*** Advanced Earth and Environmental Sciences and Inorganic Chemistry | ***Course No*** CH04-210114 | ***ECTS*** 5 |
| ***Module Affiliation*** CH04-InorgChem Inorganic Chemistry and Environmental Systems | ***Workload (hrs / sem)*** 125 | ***Level*** Bachelor 1st Year CHOICE |
| ***Course Description / Content / Aims*** Earth & Environmental Sciences: Following a continuation of a discussion of the fundamentals of geology, it will be demonstrated how physical, chemical and biological processes interact in the Earth System and drive the functions of ecosystems, and how human activities interfere with natural processes. Anthropogenic changes at local and global scales will be discussed, with emphasis on the degradation of the atmosphere, freshwater systems, soils, forests, grassland and cropland and on the changes of polar and coastal regions.<br>Inorg. Chemistry: Continuation of the introduction to chemistry that comprises the following parts: Atoms and atomic structure, the hydrogen atom, many electron atoms, periodic properties of elements. The chemical bond, ionic vs covalent bond, hydrogen bond. Molecular structure (VSEPR). | | |
| | | |
| | | |

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Enzymes and Cells in Biochemical Production | CO07-400104 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO07-ChemBiotec Chemical Biotechnology | 125 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

This lecture gives an overview of how cells and enzymes contribute to the synthesis of chemical compounds. Examples will demonstrate that biological systems can be utilized in a cost-effective manner for the mild, environmentally friendly production of chemicals. Biological conversions include biotransformations using isolated enzymes and whole cells for specific chemical conversion steps (to replace chemical catalysts) as well as de novo synthesis of complex chemicals or their precursors from simple nutrients by living cells. The basic principles of cellular metabolism will be discussed in order to provide a fundamental knowledge of how it can be exploited for chemical production. The students will read and present state-of-the-art literature in the field.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Active Participation | 10% |
| Final Exam | 60% |
| Presentation | 30% |

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Biochemical Production Lab | CO07-400114 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO07-ChemBiotec Chemical Biotechnology | 62,5 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

The lab course will provide the students with basic skills of how to practically work with enzymes and microbial cells in order to produce compounds relevant in chemical industry (biofuels, bulk chemicals and fine chemicals). A major focus will be put on the use of renewable resources for chemical production. The students will learn how to prepare media, run microbial fermentations and analyze product formation and other important process parameters.

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Bioproducts and Biosystems Engineering | CO07-400105 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO07-ChemBiotec Chemical Biotechnology | 125 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

This lecture explores the utilization of biomass as a feedstock for the production of biofuels, block chemicals and fine biochemical. Biomass conversion routes are described, namely the sugar / cellulose platform and the thermochemical platform e.g. gasification and pyrolysis. The biological and engineering aspects of such bio-refinery approaches are discussed. The design and implementation of separation methods (downstream processing) is also presented. The implementation of a bio-refinery operation is analyzed in the context of distributed biomass conversion systems or centralized plants. Emphasis is given on the dovetailing of thermochemical and fermentation-based processes with downstream recovery and purification schemes from the laboratory to the pilot plant and beyond.

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Bioproducts and Biosystems Engineering Lab | CO07-400115 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO07-ChemBiotec Chemical Biotechnology | 62,5 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

This Laboratory demonstrates the utilization of biomass as a feedstock for the production of biofuels, block chemicals and fine biochemical. The design and implementation of separation methods (downstream processing) is presented in a set of related experiments e.g. the determination of dynamic and static binding capacities of adsorbent materials, the performance of membrane separation technologies, and the utilisation of fractionation routines based on selective precipitation. Emphasis is given on the dovetailing of upstream and downstream recovery and purification schemes from the laboratory to the pilot plant and beyond.

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Analytical Chemistry | CO08-400121 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO08-PhysChem Physical and Analytical Chemistry | 125 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

Analytical chemistry is an important applied area of chemistry. Analytical chemistry deals with the separation, identification and quantification of any chemical compound. It therefore provides an interface between the traditional areas of organic, inorganic and physical chemistry with life sciences and all other areas of science requiring identification and quantification of chemical compounds. Analytical chemistry provides the tools for all areas of experimental chemistry and a good foundation of analytical techniques is not only expected of any chemist but also life scientist. The course will give an introduction into analytical chemistry with selected applications in environmental chemistry. This will include an introduction to analytical terms and definitions, basic statistic treatment of experimental data, qualitative and quantitative analysis and instrumental analysis with emphasis on spectroscopic techniques such as UV/Vis, NMR, mass spectrometry, IR and Raman spectroscopy and fluorimetry. Furthermore separation techniques such as HPLC and GC will be covered.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Final Exam | 60% |
| Home Work | 20% |
| Quizz(es) | 20% |

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Analytical Chemistry Lab | CO08-400231 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO08-PhysChem Physical and Analytical Chemistry | 62,5 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

Analytical chemistry is an important applied area of chemistry.  The Analytical chemistry laboratory will give the students practical experience in the use of modern analytical instrumentation used for compound identification and structure elucidation.
The laboratory sessions will provide set experiments using IR-, UV/VIS-NMR-spectroscopy, mass spectrometry and chromatographic techniques including gas chromatography and HPLC.
Within the course students will as well learn to critically interpret experimental data and apply basic statistical operations and error calculus to experimental data.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Tests/Reports | 100% |

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Physical Chemistry | CO08-400211 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO08-PhysChem Physical and Analytical Chemistry | 125 | Bachelor 2nd Year CORE |
| ***Course Description / Content / Aims*** | | |
| This course covers classical chemical thermodynamics and kinetics. The thermodynamics part includes the laws of thermodynamics, energy, enthalpy, entropy and free energy. They are applied to physical processes as well as chemical reactions. The kinetics part treats basic chemical kinetics laws, reactions of different order and applications to complex reaction sequences with the appropriate approximation. A final part deals with the kinetics of diffusion and ion mobility in fluid mixtures. | | |

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Physical Chemistry Lab | CO08-400262 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO08-PhysChem Physical and Analytical Chemistry | 62,5 | Bachelor 2nd Year CORE |
| ***Course Description / Content / Aims*** | | |
| This course provides training in the experimental background of physical chemistry. Examples to be covered are: Microcalorimetry, Particle sizing, Zetapotential, UV-vis and fluorescence as a tool for binding, Reaction enthalpy, Phase transition, Osmotic Pressure, Electrochemistry, | | |

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Supramolecular Chemistry | CO09-420432 | 5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO09-InorgSuMolChem Inorganic and Supramolecular Chemistry | 125 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

The course will introduce the principal design of nanomolecular systems, their characteristic properties, principal functions and applications. The focus will lie on organic and biological functional systems and on applications in the physical sciences, thus complementing the inorganic, materials-related and methodological aspects covered in Nanomolecular Science. It deals with supramolecular chemistry, the construction of nanomolecular functional systems including shuttles, photonic devices, molecular rotors and machines, and molecular containers, including biological examples and applications, e.g., drug delivery and highthroughput screening. Synthetic aspects of supramolecular assemblies, both of discrete monodisperse nature (calixarenes, functionalized fullerenes, cyclodextrins, cucurbiturils), as well as less well defined polydisperse systems like dendrimers will be discussed.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Final Exam | 50% |
| Presentation | 20% |
| Quizz 1 | 15% |
| Quizz 2 | 15% |

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Supramolecular Chemistry Lab | CO09-420434 | 2,5 |
| ***Module Affiliation*** | ***Workload (hrs / sem)*** | ***Level*** |
| CO09-InorgSuMolChem Inorganic and Supramolecular Chemistry | 62,5 | Bachelor 2nd Year CORE |

***Course Description / Content / Aims***

The goal of this lab course is to familiarize students with supramolecular chemistry in the form of hands-on lab experiences. Topics covered will include experiments concerning the formation and self-assembly of supramolecular, nanoscale structures, the thermodynamics, kinetics, and concentration-dependent phenomena of supramolecular interactions and supramolecular photochemistry. The students will synthesize supramolecular structures, perform titration experiments and analyze the obtained data. The lab course will provide a deeper understanding of receptor-ligand binding and the factors that influence binding strength and efficiency. A key part will also be the design of meaningful control experiments to exclude alternative explanations for the observed effects.

***Methods of Assessment***

| Name | Weighting |
|---|---|
| Lab Report 1 | 33% |
| Lab Report 2 | 33% |
| Lab Report 3 | 34% |

# Appendix 2 - Course Data

| ***Course Name*** | ***Course No*** | ***ECTS*** |
|---|---|---|
| Inorganic Chemistry II | CO09-400221 | 5 |
| ***Module Affiliation***<br>CO09-InorgSuMolChem Inorganic and Supramolecular Chemistry | ***Workload (hrs / sem)***<br>125 | ***Level***<br>Bachelor 2nd Year CORE |
| ***Course Description / Content / Aims***<br>This course introduces advanced concepts of inorganic chemistry, such as Molecular Structure and Bonding (VB theory, MO theory, semiconductors), Symmetry and Group Theory, Structures of Solids (metals, ionic solids), d-metal Complexes (structure and symmetry, bonding and electronic structure, reactions of complexes), The Electronic Spectra of Complexes (electronic spectra of atoms vs complexes, bonding and spectra of M-M bonded compounds). | | |
| | | |
| | | |
| ***Course Name*** | ***Course No*** | ***ECTS*** |
| Inorganic Chemistry II Lab | CO09-400232 | 2,5 |
| ***Module Affiliation***<br>CO09-InorgSuMolChem Inorganic and Supramolecular Chemistry | ***Workload (hrs / sem)***<br>62,5 | ***Level***<br>Bachelor 2nd Year CORE |
| ***Course Description / Content / Aims***<br>Synthesis, separation, purification and characterization of inorganic main-group and transition metal compounds. Quantitative analysis (gravimetric and spectrometric). Kinetics of inorganic reactions. Instrumentation used: FT-IR, UV-vis, AA, TGA, XRD, and NMR. | | |
| | | |
| | | |