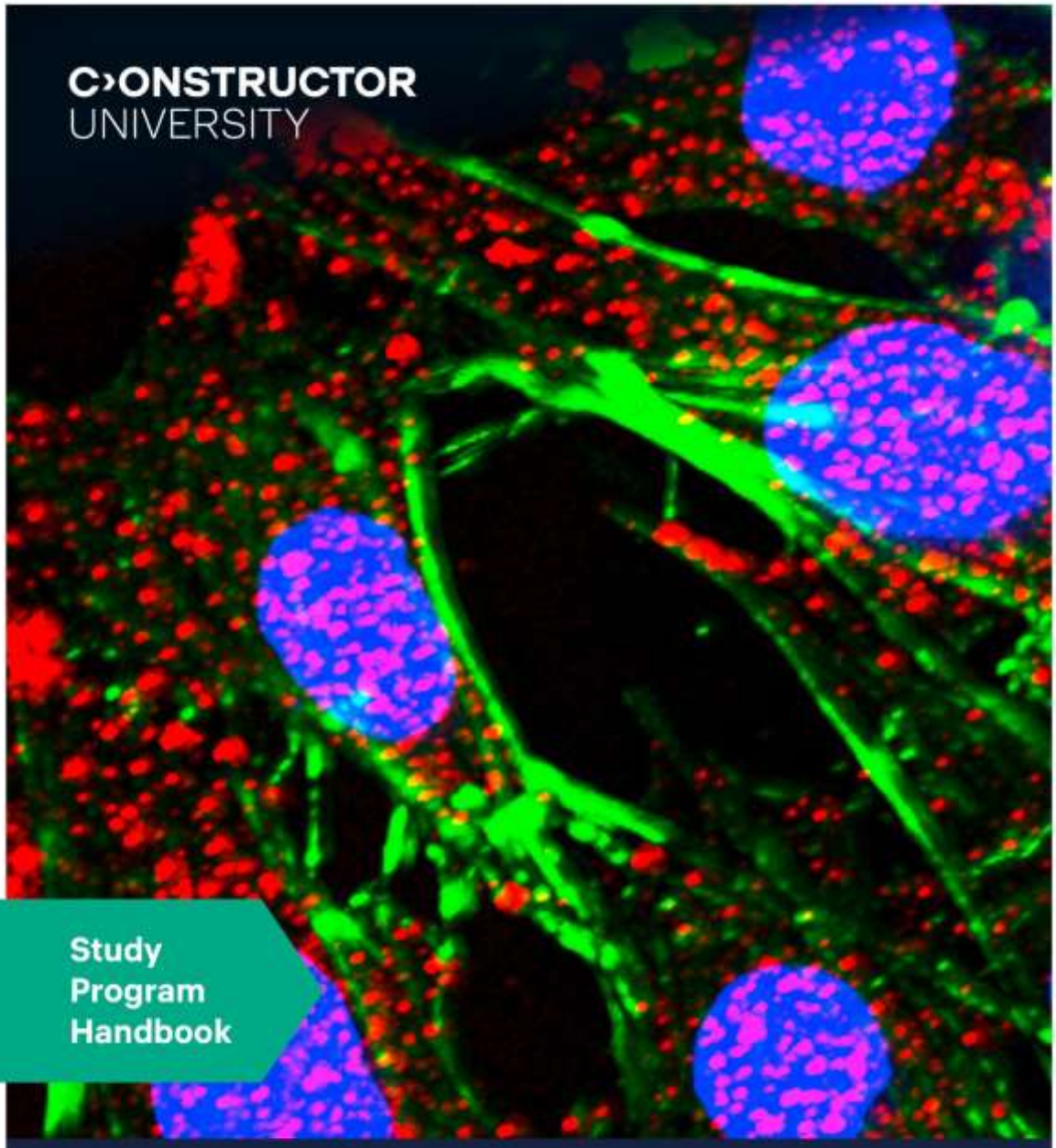
CONSTRUCTOR UNIVERSITY



Study Program Handbook

Biochemistry and Cell Biology

Bachelor of Science

Subject-specific Examination Regulations for Biochemistry and Cell Biology (Fachspezifische Prüfungsordnung)

The subject-specific examination regulations for Biochemistry and Cell Biology 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 Study and Examination Plan (Chapter 6).

Upon graduation, students in this program will receive a Bachelor of Science (BSc) degree with a scope of 180 ECTS (for specifics see Chapter 4 of this handbook)

Current version	**Valid as of**	**Decision**	**Details**
Fall 2024-V1.4		July 15, 2026	Mandatory status of Constructor Track New Skills modules changed to mandatory elective and additional methods modules offered
		June 10, 2026 May 13, 2026 April 15, 2026	Changes to Constructor Track New Skills modules
Fall 2025- V1.3		April 16, 2026	Nonsubstantial major change: Changing the "Forms of Learning and Teaching" and update of the Module Coordinator for *Agency, Leadership and Accountability.* Changes in New Skills Modules Argumentation, Data Visualization and Communication (Perspective I & II): Module coordinator,

			prerequisites removed, forms of teaching and learning. Causation & Correlation (Perspective I): Module Coordinator updated; forms of learning and teaching revised. Models, Matrices and Theories of Complex Systems: Prerequisites revised, module title updated, and module description amended. Complex Problem Solving: Module achievement added, Forms of learning and teaching updated, perquisites revised. Community Impact Project: Clarified the semester scheduling. Logic (Perspective I): Module coordinator updated, Forms of learning and teaching revised.
Fall 2025- V1.2		March 12, 2026	Removal of the module achievement for the Bachelor Thesis and Seminar
Fall 2025- V1.1		Feb 02, 2026	Implementation of Examination Concept according to policies.
		Dec 11, 2025	Non-substantial Minor Change: Introduction of the new GER module “Introduction to German Culture & Society”
Fall 2025 – V1	Sep 01, 2025		
		Apr 26, 2023	Substantial change approved by the Academic Senate
		Jun 26, 2019	Originally approved by Academic Senate

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1 Program Overview

1.1 Concept

1.1.1 The Constructor University Educational Concept

Constructor University aims to educate students for both an academic and a professional career by emphasizing three core objectives: academic excellence, personal development, and employability to succeed in the working world. Constructor University offers an excellent research driven education experience across disciplines to prepare students for graduate education as well as career success by combining disciplinary depth and interdisciplinary breadth with supplemental skills education and extra-curricular elements. Through a multi-disciplinary, holistic approach and exposure to cutting-edge technologies and challenges, Constructor University develops and enables the academic excellence, intellectual competences, societal engagement, professional and scientific skills of tomorrows leaders for a sustainable and peaceful future.

In this context, it is Constructor University's aim to educate talented young people from all over the world, regardless of nationality, religion, and material circumstances, to become citizens of the world who can take responsible roles for the democratic, peaceful, and sustainable development of the societies in which they live. This is achieved through high-quality teaching, manageable study loads and supportive study conditions. Study programs and related study abroad programs convey academic knowledge as well as the ability to interact positively with other individuals and groups in culturally diverse environments. The ability to succeed in the working world is a core objective for all study programs at Constructor University, both in terms of actual disciplinary subject matter and social skills and intercultural competence. Study-program-specific modules and additional specializations provide the necessary depth, interdisciplinary offerings and the minor option provide breadth while the university-wide general foundation and methods modules, optional German language and Humanities modules, and an extended internship period strengthen the employability of students. The concept of living and learning together on an international campus with many cultural and social activities supplements students' education. In addition, Constructor University offers professional advising and counseling.

Constructor University's educational concept is highly regarded both nationally and internationally. While the university has consistently achieved top marks over the last decade in Germany's most comprehensive and detailed university ranking by the Center for Higher Education (CHE), it has also been listed by one of the most widely observed university rankings, the Times Higher Education (THE) ranking. More details on the current ranking positions can be found at https://constructor.university/more/about-us.

1.1.2 Program Concept

Biochemistry is the study of molecules and chemical processes in living organisms, while Cell Biology addresses the structure and physiology of cells, their components, and their interactions with the environment. The two fields are combined in one comprehensive degree program, which provides students with a broad understanding of the molecular and cellular mechanisms that form the basis of life, including the principles of inheritance and gene expression. This allows BCCB graduates to address important problems in today's society in their careers, be it by basic or applied research, for example, in the areas of biomedicine, biotechnology, or molecular biology. For this, the BCCB program at

Constructor University provides not only the theoretical background, but also substantial practical training. Students are, furthermore, involved in hands-on research during their studies. As part of the Bachelor program, students receive a solid foundation in mathematics and the natural sciences Physics and Chemistry, which is an important basis for a deeper understanding of the content of the study program. In the classic teaching formats of lectures, seminars, and lab courses, various didactic approaches are implemented in the BCCB program, such as project work, game-based learning, working groups, learning by teaching, and oral or poster presentations of their own data and those of others. Together, these approaches allow students to actively engage in shaping their studies, and they lead to excellent learning outcomes. Overall, the BCCB program follows the recommendations "Subject-Specific Criteria for Bioscience Study programs" as defined by the German Conference of Biological Departments (KBF). The aim of the BCCB program is to provide a broad knowledge and competence base that qualifies students for career entry in the field of the Life Sciences and for further degree programs (MSc and/or PhD), which is what the typical BCCB graduate aims for. Our graduates often receive several competitive offers from universities and research institutions around the world to continue with graduate and PhD studies. In many cases, BCCB graduates qualify as co-authors of peer-reviewed publications in top scientific journals. BCCB, the largest major of the School of Science at Constructor University, regularly reaches top evaluations in rankings of study programs, such as the CHE or U-Multirank.

1.2 Specific Advantages of BCCB at Constructor University

The BCCB program at Constructor University combines biochemistry and cell biology from the first day of study such that the connections between these fields become clear. In the first year, students rapidly obtain an overview of the entire field of molecular life science; this helps them identify their own area of interest.

The BCCB program covers human and animal biochemistry, cell biology, molecular biology, and genetics, but is also strong in plant and microbial life science. The broad experience of Constructor University Life Sciences Faculty, and the courses they offer, allow students to also explore related subjects such as biotechnology, biophysics, bioinformatics, organic chemistry, chemical biology, drug design, marine science, food analytics, molecular immunology, and others.

The BCCB program has a very strong practical component, with excellent laboratory courses. This helps students gain the hands-on experience they need to apply for high-level internships and graduate school positions. The Bachelor thesis consists of research work in the research groups of the Life Sciences Faculty. The research carried out by BCCB students has regularly contributed to scientific publications.

Since the first years of its existence, the BCCB program has been highly successful with many students going on to graduate at high-level institutions around the world, including MSc and PhD programs (see also 1.4). Most BCCB students pursue graduate studies at the Master or PhD level, either in aspiration of an academic career or as further preparation for a leading position in related industry. As such and beyond, BCCB has an excellent track record in providing the scientific qualifications required for employability, particularly in the academic sector.

1.3 Program-Specific Educational Aims

1.3.1 Qualification Aims

The BCCB program prepares students for an academic or professional career in the field of Life Sciences:

Throughout their studies, BCCB students acquire profound and comprehensive theoretical knowledge in the fields of biochemistry, molecular biology, and cell biology, thereby gaining a thorough understanding of the principal concepts in these research areas. Furthermore, students learn how to abstract and transfer their knowledge onto new research areas, an essential skill in modern life sciences.

Presentation skills are developed through scientific poster preparation and oral presentations. In this context, students will be exposed to primary scientific literature and different research approaches enabling them to develop their own research strategies.

Theoretical education is complemented by rigorous practical training in comprehensive laboratory courses in the fields of biochemistry, cell biology, molecular biology, and microbiology. In these courses, which already start in the first semester, students acquire excellent technical skills and employ state-of-the-art methods. In addition, they learn how to accurately document and analyze scientific data through the writing of Laboratory Reports and the bachelor's thesis, all following publication-style rules. The philosophy of the BCCB program comprises working in an environment where scientific equipment is part of their daily encounters in closely guided research projects.

Through their extensive exposure to current topics in life science research conducted at Constructor University, students experience an authentic research environment that also teaches them to adhere to ethical standards and good laboratory practice. They further learn how to develop and defend their individual research project and acquire an early perspective on prospective job careers.

Intensive teamwork in laboratory courses and within research groups enables students to take responsibility for their own work and how to constructively engage in international teams in an atmosphere of mutual acceptance and respect. Consequently, BCCB graduates develop high communication competence. They are aware of intercultural differences and possess skills to deal with the challenges of a global job market.

1.3.2 Intended Learning Outcomes

By the end of the study program, students will be able to:

1. Apply basic concepts from the natural sciences (general chemistry, organic chemistry, and physics) and mathematics, including statistics;
2. Explain the basic concepts within the fields of biochemistry and cell biology;
3. Recognize general patterns of biochemical reactivity and metabolic pathways;
4. Explain how the structure and biochemical properties of biomolecules define their cellular function;
5. Explain general processes governing cellular and early developmental biology in health and diseased conditions;
6. Describe the molecular principles underlying gene expression and regulation;
7. Apply state-of-the-art techniques to experimentally analyze biomolecules and cells;

8. Collect, analyze, and evaluate relevant literature within the fields of biochemistry, molecular biology, and cell biology;
9. Use their acquired theoretical knowledge and practical skills to design and implement experimental approaches to address scientific questions in modern Life Sciences;
10. Generate, analyze, and interpret data according to good scientific practice and ethical standards;
11. Present their own results, and those of others, concisely and professionally both in writing and in front of an audience;
12. Develop and advance solutions to problems in Life Sciences and defend these in discussions with specialists and non-specialists;
13. Explore related subjects such as biotechnology, biophysics, bioinformatics, organic chemistry, drug design, marine science, food analytics, and others;
14. Acquire knowledge rapidly, and gather, evaluate, and interpret relevant information and evaluate new concepts critically to derive scientifically founded judgments;
15. Evaluate situations and make decisions based on ethical considerations, and adhere to and defend ethical, scientific, and professional standards;
16. Negotiate and mediate between different points of view and manage conflicts;
17. Analyze global issues of an economic, political, scientific, social, or technological nature;
18. Take responsibility in diverse and interdisciplinary teams, exhibiting tolerance and intercultural awareness;
19. Take responsibility for their own and their team's learning, personal, and professional development and role in society, evaluating critical feedback and using self-analysis;
20. Take responsibility for their professional community and society.

1.4 Career Options and Support

Most BCCB graduates move on to graduate education, and past graduates of this program have enrolled at prestigious universities around the world. To these belong MSc and PhD programs at Imperial College London, LMU Munich, University of Heidelberg, University of Göttingen, ETH Zurich, EPF Lausanne, European Molecular Biology Laboratories (EMBL), various International Max Planck Research Schools (IMPRS), the University of Oxford, the University of Cambridge, Cornell University, Duke University, New York University, Yale, MIT, and Harvard.

The applied curriculum of the BCCB program with many laboratory courses also enables graduates to find work as lab researchers, in other research-related positions, in product development, technical support, marketing or sales in biotech, food or pharmaceutical companies, as well as government agencies. Some graduates have also found non-traditional careers such as management, science policy, or science writing. Outside academia, past graduates of this program work for Arthrex, Autodesk, Catenion, Roche, Leroy Merlin, Boston Consulting Group, the non-profit partnership Medicines for Malaria Venture and many others.

The Career Service Center (CSC) helps students in their career development. It provides students with high-quality training and coaching in CV creation, cover letter formulation, interview preparation, effective presentation, business etiquette, and employer research as well as in many other aspects, thus helping students identify and follow up on rewarding careers after graduating from Constructor

University. Furthermore, the Alumni Office helps students establish a long-lasting and global network which is useful when exploring job options in academia, industry, and elsewhere.

1.5 Admission Requirements

Admission to Constructor University is selective and based on a candidate's school and/or university achievements, recommendations, self-presentation, and performance on standardized tests. Students admitted to Constructor University demonstrate exceptional academic achievements, intellectual creativity, and the desire and motivation to make a difference in the world.

The following documents need to be submitted with the application:

- Recommendation Letter (optional)
- Official or certified copies of high school/university transcripts
- Educational History Form
- Standardized test results (SAT/ACT) if applicable
- Motivation statement
- ZeeMee electronic resume (optional)
- Language proficiency test results (TOEFL Score: 90, IELTS: Level 6.5 or equivalent)

Formal admission requirements are subject to higher education law and are outlined in the Admission and Enrollment Policy of Constructor University.

For more detailed information about the admission visit: https://constructor.university/admission-aid/application-information-undergraduate

1.6 More information and contacts

For more information on the study program please contact the Study Program Coordinator:

Prof. Dr. Susanne Illenberger

Distinguished Lecturer in Biochemistry and Cell Biology

Dean School of Science

Email: sillenberger@constructor.university

or visit our program website: https://constructor.university/programs/undergraduate-education/biochemistry-cell-biology

For more information on Student Services please visit:

https://constructor.university/student-life/student-services

2 The Curricular Structure

2.1 General

The curricular structure provides multiple elements for enhancing employability, interdisciplinarity, and internationality. The unique CONSTRUCTOR Track, offered across all undergraduate study programs, provides comprehensive tailor-made modules designed to achieve and foster career competency. Additionally, a mandatory internship of at least two months after the second year of study and the possibility to study abroad for one semester give students opportunities to gain insight into the professional world, apply their intercultural competences and reflect on their roles and ambitions for employment and in a globalized society.

All undergraduate programs at Constructor University are based on a coherently modularized structure, which provides students with an extensive and flexible choice of study plans to meet the educational aims of their major as well as minor study interests and complete their studies within the regular period.

The framework policies and procedures regulating undergraduate study programs at Constructor University can be found on the website (https://constructor.university/student-life/student-services/university-policies)

2.2 The Constructor University 4C Model

Constructor University offers study programs that comply with the regulations of the European Higher Education Area. All study programs are structured according to the European Credit Transfer System (ECTS), which facilitates credit transfer between academic institutions. The three-year undergraduate programs involve six semesters of study with a total of 180 ECTS credit points (CP). The undergraduate curricular structure follows an innovative and student-centered modularization scheme, the 4C Model. It groups the disciplinary content of the study program in three overarching themes, CHOICE-CORE-CAREER according to the year of study, while the university-wide CONSTRUCTOR Track is dedicated to multidisciplinary content dedicated to methods as well as intellectual skills and is integrated across all three years of study. The default module size is 5 CP, with smaller 2.5 CP modules being possible as justified exceptions, e.g., if the learning goals are more suitable for 2.5 CP and the overall student workload is balanced.

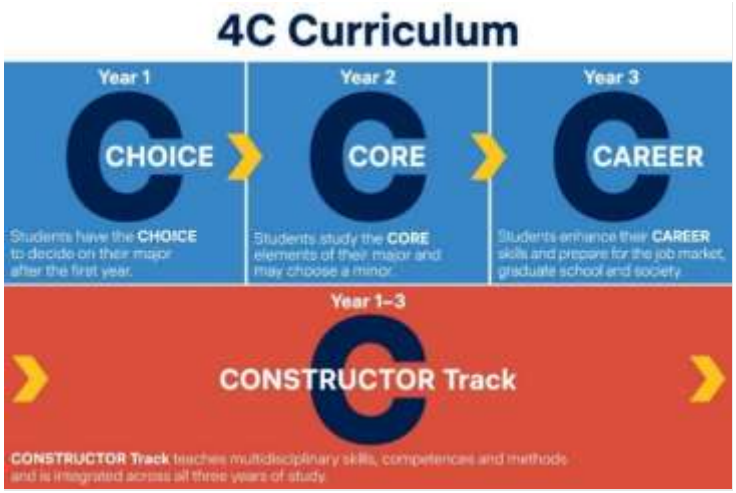

Figure 1: The Constructor University 4C-Model

2.2.1 Year 1 – CHOICE

The first study year is characterized by a university-specific offering of disciplinary education that builds on and expands upon the students' entrance qualifications. Students select introductory modules for a total of 45 CP from the CHOICE area of a variety of study programs, of which 15-45 CP will belong to their intended major. A unique feature of our curriculum structure allows students to select their major freely upon entering Constructor University. The team of Academic Advising Services offers curriculum counseling to all Bachelor students independently of their major, while Academic Advisors, in their capacity as contact persons from the faculty, support students individually in deciding on their major study program.

To pursue Biochemistry and Cell Biology (BCCB) as a major, the following CHOICE modules (30 CP) need to be taken as mandatory (m) modules:

- CHOICE Module: General Biochemistry (m, 7.5 CP)
- CHOICE Module: General and Inorganic Chemistry (m, 7.5 CP)
- CHOICE Module: General Cell Biology (m, 7.5 CP)
- CHOICE Module: General Organic Chemistry (m, 7.5 CP)

The mandatory CHOICE Modules of the BCCB major are planned out and consist of integrated lecture and laboratory course module components. The CHOICE General Biochemistry Module will explain how to apply and analyze basic concepts of biochemistry, while the CHOICE General Cell Biology Module introduces students to cells that are the minimal functional units of life. Both BCCB-specific modules find their essential foundations and complementation in the CHOICE General and Inorganic Chemistry and General Organic Chemistry Modules, in which the underlying principles of chemical reactions and organic molecules are conveyed. Thus, the macromolecular composition of cells, general principles of cellular and biochemical processes, as well as molecular biological codes provided by the genome, the transcriptome, and the proteome will be the focus of the complementary components of the mandatory BCCB CHOICE Modules at large. Physiology and pathological alterations bringing about diseases will be introduced alongside this. In-lab experiences will encompass the documentation, description, and discussion of experimental data, while awareness and the following of safety rules and regulations are explained and trained.

The remaining CHOICE modules (15 CP) can be selected in the first year of study according to interest and/or with the aim of allowing a change of major until the beginning of the second year, when the major choice becomes fixed.

Students can still change to another major at the beginning of their second year of studies, provided they have taken the corresponding mandatory CHOICE modules in their first year of studies. All students must participate in an entry advising session with their Academic Advisors to learn about their major change options and consult their Academic Advisor prior to changing their major.

Students that would like to retain a further option are strongly recommended to additionally register for the CHOICE modules of one of the following study programs in their first year:

- Chemistry and Biotechnology (CBT)
  CHOICE Module: Introduction to Biotechnology: Microbiology and Genetics (m, 7.5 CP)

- Medicinal Chemistry and Chemical Biology (MCCB)
  CHOICE Module: General Medicinal Chemistry and Chemical Biology (m, 7.5 CP)

- Integrated Social and Cognitive Psychology (ISCP)
  CHOICE Module: Essentials of Cognitive Psychology (m, 7.5 CP)
  CHOICE Module: Essentials of Social Psychology (m, 7.5 CP)

- International Relations: Politics and History (IRPH)
  CHOICE Module: Introduction to International Relations Theory (m, 7.5 CP)
  CHOICE Module: Introduction to Modern European History (m, 7.5 CP)

Typically, students interested in BCCB will have a genuine interest in the molecular life sciences. Therefore, CHOICE Modules from the related majors "Chemistry and Biotechnology" (CBT) and “Medicinal Chemistry and Chemical Biology” (MCCB) are recommended as fitting complementation (see above). In the past, students have also declared interest in "Integrated Social and Cognitive Psychology" (ISCP). These students would thus be advised to choose the respective CHOICE Modules during their first year of study.

2.2.2 Year 2 – CORE

In their second year, students take a total of 45 CP from a selection of in-depth, discipline-specific CORE modules. Building on the introductory CHOICE modules and applying the methods and skills students have already acquired so far (see 2.3.1), these modules aim to expand the students’ critical understanding of the key theories, principles, and methods in their major for the current state of knowledge and best practice.

To pursue BCCB as a major, 35 CP from the following mandatory CORE modules need to be acquired:

- CORE Module: Advanced Biochemistry I (m, 5 CP)
- CORE Module: Advanced Biochemistry II (m, 5 CP)
- CORE Module: Advanced Biochemistry Lab (m, 5 CP)
- CORE Module: Advanced Cell Biology I (m, 5 CP)
- CORE Module: Advanced Cell Biology II (m, 5 CP)
- CORE Module: Advanced Cell Biology Lab (m, 5 CP)
- CORE Module: Microbiology (m, 5 CP)

The mandatory CORE Modules of the BCCB program are built on the BCCB CHOICE modules and are thought to deepen the knowledge in each of the two core fields of this major: biochemistry and cell biology. For either field, the CORE modules encompass two lectures and a laboratory course. To account for the wealth of information and the fast development in knowledge acquisition, as well as methodological advances in these rapidly enhancing scientific fields, the modules are staggered from the third to the fourth semester. The "Advanced Biochemistry I/II" modules cover energy production by living organisms, synthesis and degradation of biomolecules and principles of metabolism. Moreover, they address how genetic information is replicated, controlled and expressed in pro- and eukaryotic cells, and how DNA repair is realized at an advanced level. The "Advanced Cell Biology I/II" modules provide an in-depth view on the complexity of cellular systems, the regulation of key cellular processes and their integration in tissue formation and organismal organization, including regulatory

mechanisms that allow for coordinated early development in specific model organisms. These modules will also address principles of genetics and evolution and discuss consequences of alterations upon loss of homeostasis or stress, thereby approaching biomedical implications leading to disease.

In the laboratory modules, students will perform experiments to elucidate the relationship between structure, biochemical properties, and activity of biomolecules, both *in vitro* and in a cellular context. For example, proteins tagged by the green fluorescent protein (GFP) will be expressed and biochemically characterized in the Advanced Biochemistry Laboratory module, while protein trafficking and functioning in different cellular compartments will be analyzed using GFP-tagged proteins in combination with different targeting signals in the Advanced Cell Biology Laboratory module. Methods range from standard techniques like chromatography, gel electrophoresis, spectrophotometry to genetic engineering of plasmid vectors, the genetic manipulation of cells and advanced laser scanning microscopy. Result documentation, analysis and discussion will be accomplished through publication-style laboratory reports.

The mandatory module "Microbiology" addresses the diversity of microorganisms, their manifold biochemically diverse lifestyles and adaptations to various environments. This includes the exploration of how microbes contribute to the cycling of elements on our planet, and the analysis of host-pathogen interactions. Students will also learn about strategies to fight microbial contaminations and pathogens.

Students may decide to complement their studies by taking the discipline-specific mandatory elective (me) CORE modules (10 CP)

- CORE Module: Microbiology Lab (me, 2.5 CP)
- CORE Module: Infection and Immunity (me, 7.5 CP)

In the "Microbiology Lab", students will identify environmental bacteria through biochemical and sequence analyses. The lecture module "Infection and Immunity" (7.5 CP) explores microbial biology and pathogenicity as well as host-pathogen interactions consideringthe human immune system as an efficient defense mechanism.

Alternatively, BCCB students may substitute the mandatory elective CORE modules "Microbiology Lab", "Infection and Immunity" as well as the mandatory elective Methods/Skills module of the third semester with 15 CP from CORE modules from a second field of studies according to interest with the aim to pursue a minor.

BCCB students can take CORE modules (or more advanced Specialization modules) from a second discipline, which allows them to incorporate a minor study track into their undergraduate education, within the 180 CP required for a bachelor's degree. The educational aims of a minor are to broaden the students' knowledge and skills, support the critical reflection of statements in complex contexts, foster an interdisciplinary approach to problem-solving, and to develop an individual academic and professional profile in line with students' strengths and interests. This extra qualification will be highlighted in a student`s final transcript.

The Academic Advising Coordinator, Academic Advisor, and the Study Program Chair of the minor study program support students in the realization of their minor selection; consultation with the Academic Advisor is mandatory when choosing a minor.

As a rule, this requires BCCB students to:

- select CHOICE modules (15 CP) from the desired minor program in the first year and

- substitute the mandatory elective BCCB CORE modules "Microbiology Lab" and "Infection and Immunity" and the mandatory elective methods module in the third semester (15 CP total) with the default minor CORE modules of the minor study program.

The requirements for the specific minors are described in the handbook of the study program offering the minor (chapter 3.2) and are marked in the respective Study and Examination Plans. For an overview of accessible minors, please check the Major/Minor Combination Matrix, which is published at the beginning of each academic year.

2.2.3 Year 3 – CAREER

During their third year, students prepare and make decisions for their career after graduation. To explore available choices fitting individual interests, and to gain professional experience, students take a mandatory summer internship (see 2.2.3.1). The third year of studies allows BCCB students to further sharpen their profile with a selection of discipline-specific, research-oriented specialization modules that can be combined to enhance their individual competences in the natural sciences, strategy development for novel research approaches or managerial capabilities. Furthermore, the third year also focuses on the responsibility of students beyond their discipline (see CONSTRUCTOR Track).

The fifth semester also opens a mobility window for a diverse range of study abroad options. Finally, the sixth semester is dedicated to fostering the students' research experience by involving them in a Bachelor thesis project.

Internship / Start-up and Career Skills Module

As a core element of Constructor University's employability approach, students are required to engage in a mandatory two-month internship of 15 CP that will usually be completed during the summer between the second and third years of study. This gives students the opportunity to gain first-hand practical experience in an external professional research environment, apply their knowledge and understanding in the context of an external institution, reflect on the relevance of their major to employment and society, reflect on their own personal role, and further develop their professional orientation. The internship can establish valuable contacts for the students' bachelor's thesis project, for the selection of a master program or graduate school, or for further employment after graduation. This module is complemented by career advising and several career skills workshops throughout all six semesters that prepare students for the transition from student life to professional life. As an alternative to the full-time internship, students interested in setting up their own company can apply for a start-up option to focus on developing their business plans.

For further information, please contact the Career Service Center (CSC) (https://constructor.university/student-life/career-services)

For organizational aspects consult with your Academic Advisor and the BCCB SPC for reasonable choices to conduct a prosperous internship.

Specialization Modules

In the third year of their studies, students take 15 CP from major-specific or major-related, advanced Specialization Modules to consolidate their knowledge and to be exposed to state-of-the-art research in the areas of their interest. This curricular component is offered as a portfolio of modules, from which

students can make free selections during their fifth and sixth semester. The default Specialization Module size is 5 CP, with smaller 2.5 CP modules being possible as justified exceptions.

To pursue BCCB as a major, at least 10 of the 15 CP from the following major-specific Specialization Modules need to be taken:

- BCCB Specialization: Experimental Strategy Design (me, 5 CP)
- BCCB Specialization: Biomedicine (me, 5 CP)
- BCCB Specialization: Current Topics in the Molecular Life Sciences (me, 5 CP)

A maximum of 5 CP can be taken from major-related modules instead of major-specific Specialization Modules:

- CBT Specialization: Environmental Microbiology and Biotechnology (me, 5 CP)
- CBT CORE Module: Industrial Biotechnology (me, 5 CP)
- CBT CORE Module: Scientific Software and Databases (me, 5 CP)
- MCCB Specialization: Synthetic Biology (me, 5 CP)
- MCCB Specialization: Drug Discovery (me, 2.5 CP)
- MCCB CORE Module: Chemical Biology (me, 5 CP)
- ISCP CORE Module: Neurobiology of Behavior (me, 5 CP)
- ISCP CORE Module: Neuroscience Methods (me, 5 CP)

Students may also select 15 CP entirely from their major-specific Specialization Modules.

The specialization modules in the BCCB program aim at critical discussions and evaluations of current advances in different research fields of the molecular life sciences to unravel and apply the fascinating complexity of biological systems in basic and applied sciences. Although from different perspectives, the BCCB Specialization Modules will address scientific challenges in the 21st century and how scientists tackle them. The module contents will enable students to formulate hypotheses, develop a strategy to approach any research question experimentally, predict possible experimental outcomes, and how the experiments need to be controlled to finally draw a conclusion from their own data or the results of others. In this context, the regulatory frameworks governing activities in the bioscience field will be discussed and the principles for creating and realizing research projects in the fast-progressing fields of life sciences will be outlined. The module contents will take into consideration the societal context in a world with increasing cultural and socio-economic diversity, for example, by critically deducing today’s challenges in designing research projects in the basic sciences and by aiming at translation in the clinics.

Hypothesis-driven research is the central element in "Experimental Strategy Design," where students will expand their methodological knowledge through literature analysis, assessing the benefits and limitations of state-of-the-art techniques, which will enable them to eventually design their own research strategy to answer a given scientific question. The "Biomedicine" module will analyze how biological processes can go wrong in disease, which molecular regulators are targeted in designing therapeutic approaches and new treatment options, and how diagnostic tools can be developed. In "Current Topics," students will analyze recent scientific articles in a seminar-style format where students present the authors' rationale and experimental design and debate the experimental outcomes through in-class discussions.

Study Abroad

Students can study abroad for a semester to extend their knowledge and abilities, broaden their horizons and reflect on their values and behavior in a different context as well as on their role in a global society. For a semester abroad (usually the fifth semester), modules related to the major with a workload equivalent to 22.5 CP must be completed. Modules recognized as study abroad CP need to be pre-approved according to Constructor University's study abroad procedures. Several exchange programs allow students to directly enroll at prestigious partner institutions worldwide. Constructor University's participation in Erasmus+, the European Union's exchange program, provides an exchange semester at several European universities that include Erasmus study abroad funding.

For further information, please contact the International Office

(https://constructor.university/student-life/study-abroad/international-office)

BCCB students who wish to pursue a study abroad in their fifth semester are required to select their modules at the study abroad partners such that they can be used to substitute between 10-15 CP of major-specific Specialization modules and between 5-15 CP of modules equivalent to the non-disciplinary New Skills modules (see CONSTRUCTOR Track). In their sixth semester, according to the study plan, returning study-abroad students complete the Bachelor Thesis/Seminar module (see next section), they take any missing Specialization modules to reach the required 15 CP in this area, and they take any missing New Skills modules to reach the required 15 CP in this area.

BCCB students will typically choose institutions for study abroad where they can apply their factual knowledge and expand their experimental skills to broaden their methodological expertise. Furthermore, this option offers students the opportunity to explore additional research fields complementary to the BCCB curriculum, such as evolutionary developmental biology, neurobiology, structural biology, virology, etc.

Bachelor Thesis/Seminar Module

This module is a mandatory graduation requirement for all undergraduate students. It consists of two module components in the major study program guided by a Constructor University faculty member: the Bachelor Thesis (12 CP) and a Seminar (3 CP). The title of the thesis will appear on the students' transcripts.

Within this module, students apply the knowledge skills and methods they have acquired in their major discipline 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. The data will be analyzed and interpreted according to good scientific practice and ethical standards. Hence, the results of students' work will be set into context with the regulatory frameworks governing activities in the bioscience field.

With their Bachelor Thesis students demonstrate mastery of selected contents and methods of their major-specific research field. Furthermore, students 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 the original development of their own ideas. With the permission of a Constructor University Faculty Supervisor, the Bachelor Thesis can also have an interdisciplinary nature. In the seminar, students present and discuss their theses in a course environment and reflect on their theoretical or

experimental approach and conduct. They learn to present their chosen research topics concisely and comprehensively in front of an audience and to explain their methods, solutions, and results to both specialists and non-specialists.

2.3 The CONSTRUCTOR Track

The CONSTRUCTOR Track is another important feature of Constructor University's educational model. The Constructor Track runs orthogonal to the disciplinary CHOICE, CORE, and CAREER modules across all study years and is an integral part of all undergraduate study programs. It provides an intellectual tool kit for lifelong learning and encourages the use of diverse methodologies to approach cross-disciplinary problems. The CONSTRUCTOR track contains Methods, New Skills and German Language and Humanities modules.

2.3.1 Methods Modules

Methods such as mathematics, statistics, programming, data handling, presentation skills, academic writing, and scientific and experimental skills are offered to all students as part of the Methods area in their curriculum. The modules that are specifically assigned to each study program to equip students with transferable academic skills. They convey and practice specific methods that are indispensable for each student's chosen study program. Students are required to take 20 CP in the Methods area. The size of all Methods modules is 5 CP.

To pursue BCCB as a major, the following mandatory Methods and Skills (15 CP) need to be taken:

- Methods Module: Mathematical Concepts for the Sciences (m, 5 CP)
- Methods Module: Physics for the Natural Sciences (m, 5 CP)
- Methods Module: Plant Metabolism and Natural Products (m, 5 CP)

For the remaining 5 CP BCCB students can choose between the two Methods modules

- Methods Module: Introduction to Bioinformatics (me, 5 CP)
- Methods Module: Analytical Methods (me, 5 CP)

BCCB students can choose one of the following modules as an additional methods module replacing 5 CP in the New Skills area:

- Programming in Python (me, 5 CP)
- Introduction to Bioinformatics (me, 5 CP) or Analytical Methods (me, 5 CP) *
- Statistics and Data Analytics (me, 5 CP)

*Depending on which of these modules was chosen in the third semester by BCCB students.

2.3.2 New Skills Modules

This part of the curriculum constitutes an intellectual and conceptual tool kit that cultivates the capacity for a particular set of intellectual dispositions including curiosity, imagination, critical thought, and transferability. It nurtures a range of individual and societal capacities, such as self-reflection, argumentation and communication. Finally, it introduces students to the normative aspects of inquiry and research, including the norms governing sourcing, sharing, withholding materials and research

results as well as others governing the responsibilities of expertise as well as the professional point of view.

All students are required to take 20 CP of New Skills modules in their second and third year of studies. Of the 20 CP required for New Skills modules, BCCB students may replace 5 CP with an additional Methods/Skills module from the list of offerings mentioned in section 2.3.1.

Students choose New Skills Modules from the following portfolio:

- New Skills Module: Logic* (me, 2.5 CP)
- New Skills Module: Causation and Correlation* (me, 2.5 CP)
- New Skills Module: Argumentation, Data Visualization and Communication* (me, 5 CP)
- New Skills Module: Models, Matrices and Theories of Complex Systems (me, 5 CP)
- New Skills Module: Complex Problem Solving (me, 5 CP)
- New Skills Module: Agency, Leadership and Accountability (me, 5 CP)
- New Skills Module: Community Impact Project (me, 5 CP)

Some of these modules (marked by *) will be offered with two different perspectives from which the students can only choose one for the fulfillment of graduation requirements of their degree program. The module perspectives are independent modules which examine the topic from different points of view. Please see the module description in chapter 6 for more details such as scheduling, content and assessment.

2.3.3 German Language and Humanities Modules

Students are required to take 5 CP of German language or Humanities modules. German language abilities foster students' intercultural awareness and enhance their employability in their host country. They are also beneficial for securing mandatory internships (between the 2nd and 3rd year) in German companies and academic institutions. Constructor University supports its students in acquiring basic as well as advanced German skills in the first year of the CONSTRUCTOR Track. Non-native speakers of German are encouraged to take two German modules (me, 2.5 CP each) but are not obliged to do so. Native speakers and other students who are not taking advantage of this offer take alternative modules in Humanities in each of the first two semesters:

- Humanities Module: Introduction to Philosophical Ethics (me, 2.5 CP)
- Humanities Module: Introduction to the Philosophy of Science (me, 2.5 CP)
- Humanities Module: Introduction to Visual Culture (me, 2.5 CP)

3 BCCB as a Minor

The typical target group aiming at a Minor in BCCB are students with a genuine interest in neighboring disciplines that can be any of the following: bioinformatics, biotechnology, chemistry, environmental sciences, physics, or psychology. All of these fields of study connect to the scientific questions asked, approached, and solved in the molecular life sciences for which BCCB provides the basic scientific foundations. Students who are mainly interested in the theoretical foundations of the field are invited to follow the enriching experience in BCCB by enrolling with a Minor.

3.1 Qualification Aims

In the BCCB CHOICE modules, students will receive an overview about the different classes of biomolecules and how their intricate interplay defines cellular architecture and function. They will also acquire basic experimental skills to develop a general understanding of core methodology. These foundations are complemented by the study of microbiology, host pathogen interactions, and immune defense to demonstrate the complexity of the field and relate fundamental research to key challenges in modern societies, for example, multiple drug resistance in bacteria and immunotherapy in cancer treatment. Understanding the basic principles underlying molecular life sciences and their applications is a key asset that will enable students to become a reasonable politician, to enroll in decision-making boards, and to empower society with respect to the biological revolution, which is only at the beginning of exploitation.

3.1.1 Intended Learning Outcomes

With a minor in BCCB, students will be able to:

- Explain the basic concepts within the fields of biochemistry and cell biology;
- Explain how the structure and biochemical properties of biomolecules define their cellular function;
- Explain general processes governing cellular and early developmental biology in health and diseased condition;
- Describe the molecular principles underlying gene expression and regulation;
- Apply state-of-the-art techniques to experimentally analyze biomolecules and cells;
- Generate, analyze, and interpret data according to good scientific practice and ethical standards;
- Rapidly acquire knowledge, and gather, evaluate, and interpret relevant information, and critically evaluate new concepts to derive scientifically founded judgements;
- Evaluate situations and make decisions based on scientific knowledge and ethical considerations, and adhere to and defend ethical, scientific, and professional standards;
- Take responsibility in diverse and interdisciplinary teams, exhibiting tolerance and intercultural awareness;
- Take responsibility for their own and their team's learning, personal and professional development, and role in society, evaluating critical feedback and using self-analysis.

3.2 Module Requirements

A minor in BCCB requires 30 CP. The default option to obtain a minor in BCCB is marked in the Study and Examination Plan in chapter 6. It includes the following mandatory CHOICE and CORE modules:

- CHOICE Module: General Biochemistry (m, 7.5 CP)
- CHOICE Module: General Cell Biology (m, 7.5 CP)
- CORE Module: Microbiology (m, 5 CP)
- CORE Module: Microbiology Lab (m, 2.5 CP)
- CORE Module: Infection and Immunity (m, 7.5 CP)

3.3 Degree

After successful completion, the minor in BCCB will be listed on the final transcript under PROGRAM OF STUDY and BA/BSc – [name of the major] as “(Minor: Biochemistry and Cell Biology)."

4 BCCB Undergraduate Program Regulations

4.1 Scope of these Regulations

The regulations in this handbook are valid for all students who entered the Biochemistry and Cell Biology undergraduate program at Constructor University in Fall 2025. In case of a conflict between the regulations in this handbook and the general Policies for Bachelor Studies, the latter apply (see https://constructor.university/student-life/student-services/university-policies)

In exceptional cases, certain necessary deviations from the regulations of this study handbook might occur during the course of study (e.g., change of the semester sequence, assessment type, or the teaching mode of courses).

Updates to Study Program Handbooks are based on the policies approved by the Academic Senate on substantial and non-substantial changes to study programs. Students are integrated into the decision-making process through their respective committee representatives. All students affected by the changes will be properly informed.

In general, Constructor University therefore reserves the right to change or modify the regulations of the program handbook also after its publication at any time and in its sole discretion.

4.2 Examination Concept

According to the Policies for Bachelor and Master studies, modules generally carry at least five ECTS. Each program ensures appropriate examination frequency and organization, justified in an examination concept and regularly reviewed with student involvement.

Constructor University's examination concept follows the principle of Constructive Alignment (Biggs, 1996), ensuring that learning outcomes, activities, and assessments are consistently aligned: students learn what is intended, and assessments both measure and shape learning. Where one assessment cannot cover all Intended Learning Outcomes (ILOs) complementary forms could be used (e.g., written exams plus lab reports). Module descriptions map ILOs to assessments.

In specific contexts, such as asynchronous online modules or courses emphasizing student engagement, Module Achievements or other types of formative assessments may support competence-oriented assessment.

Student feedback, embedded in the Quality Assurance System (QAS), systematically monitors workload, competence orientation, and alignment of ILOs and assessments. Student surveys and feedback are regulated in the Policy for student surveys and evaluations.

4.3 Degree

Upon successful completion of this study program, students are awarded a Bachelor of Science degree in Biochemistry and Cell Biology.

4.4 Graduation Requirements

To graduate, students need to obtain 180 CP. In addition, the following graduation requirements apply:

Students need to complete all mandatory components of the program as indicated in the Study and Examination Plan in Chapter 6 of this handbook.

4.5 Schematic Study Scheme for BCCB

Figure 2 shows schematically the sequence and types of modules required for the study program. A more detailed description, including the assessment types, is given in the Study and Examination Plans in the following section.

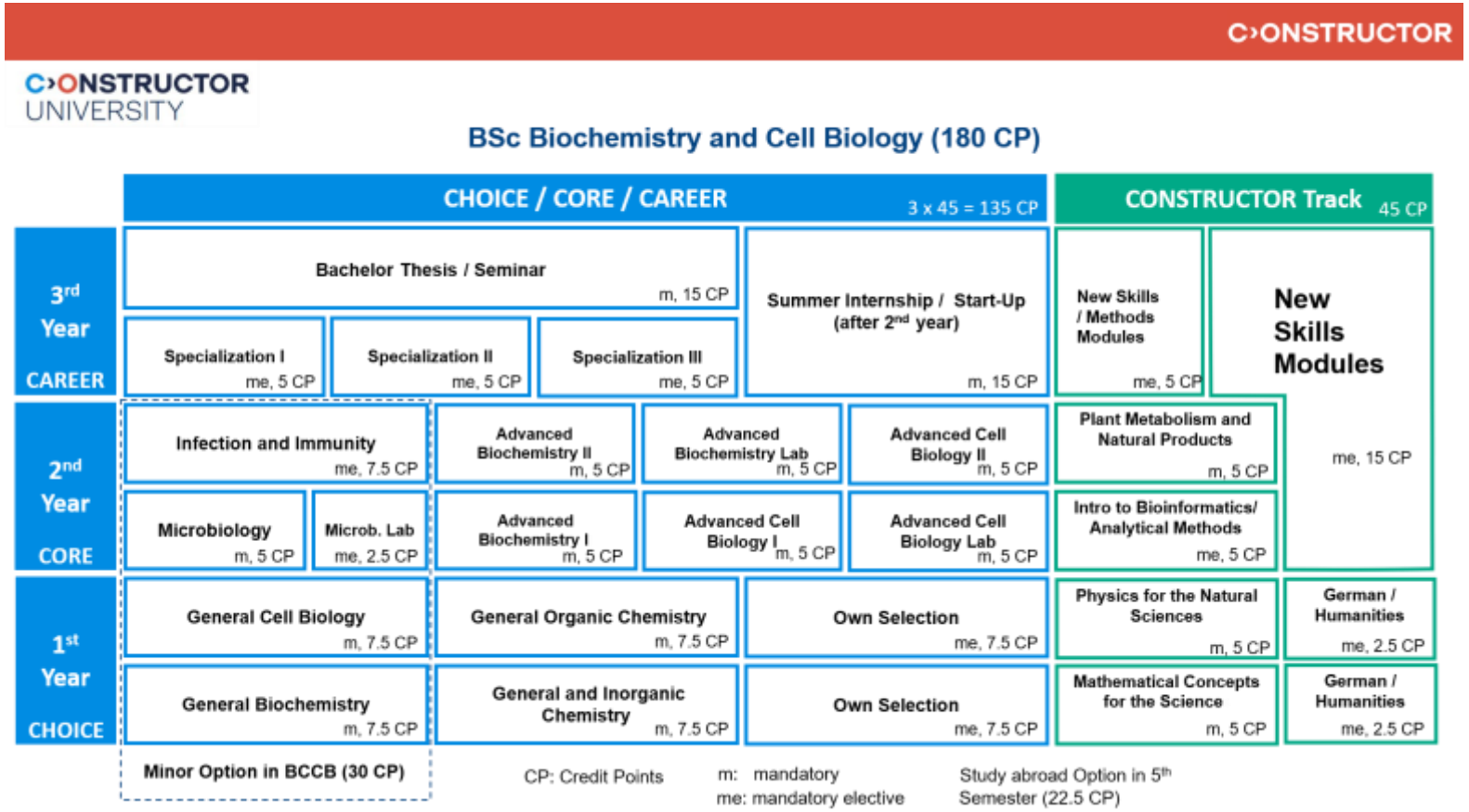

Figure 2: Schematic Study Scheme for BCCB

4.6 Study and Examination Plan

Biochemistry and Cell Biology

Matriculation Fall 2025

	Program-Specific Modules	Type	Assessment	Period	Status[1]	Sem.	CP
Year 1 - CHOICE							**45**
Take the mandatory CHOICE modules listed below, this is a requirement for the BCCB program.							
	Unit: General BCCB (Default minor)						**15**
CH-100	**Module: General Biochemistry** (Default minor)				**m**	**1**	**7.5**
CH-100-A	General Biochemistry	Lecture	Written examination	Examination period			5
CH-100-B	General Biochemistry Lab	Lab	Laboratory report	During the semester			2.5
CH-101	**Module: General Cell Biology** (Default minor)				**m**	**2**	**7.5**
CH-101-A	General Cell Biology	Lecture	Written examination	Examination period			5
CH-101-B	General Cell Biology Lab	Lab	Laboratory report	During the semester			2.5
	Unit: Chemistry						**15**
CH-120	**Module: General and Inorganic Chemistry**				**m**	**1**	**7.5**
CH-120-A	General and Inorganic Chemistry	Lecture	Written examination	Examination period			5
CH-120-B	General and Inorganic Chemistry Lab	Lab	Laboratory report	During the semester			2.5
CH-111	**Module: General Organic Chemistry**				**m**	**2**	**7.5**
CH-111-A	General Organic Chemistry	Lecture	Written examination	Examination period			2,5
CH-111-B	General Organic Chemistry Lab	Lab	Laboratory report	During the semester			5
	Unit: CHOICE (own selection)					**1/2**	**15**
	Students take two further CHOICE modules from those offered for all other study programs.[2]						
Year 2 - CORE							**45**
Take all CORE modules listed below or replace the mandatory elective (me) modules (10CP) with suitable CORE modules from other study programs[2]							
	Unit: Microbiology, Infection and Immunity						**15**
CO-400	**Module: Microbiology (Default minor)**				**m**	**3**	**5**
CO-400-A	Microbiology	Lecture	Written examination	Examination period			
CO-408	**Module: Microbiology Lab**				**me[3]**	**3**	**2.5**
CO-408-A	Microbiology Lab	Lab	Laboratory report	During the semester			
CO-401	**Module: Infection and Immunity**				**me[3]**	**3**	**7.5**
CO-401-A	Immunology	Lecture	Written examination	Examination period			5
CO-401-B	Microbial Pathogenicity	Lecture	Written examination	Examination period			2.5
	Unit: Advanced Biochemistry						**15**
CO-402	**Module: Advanced Biochemistry I**				**m**	**3**	**5**
CO-402-A	Metabolic Pathways	Lecture	Written examination	Examination period			5
CO-403	**Module: Advanced Biochemistry II**				**m**	**4**	**5**
CO-403-A	Molecular Genetics	Lecture	Written examination	Examination period			5
CO-404	**Module: Advanced Biochemistry Lab**				**m**	**4**	**5**
CO-404-A	Advanced Biochemistry Laboratory Course	Lab	Laboratory report	During the semester			5
	Unit: Advanced Cell Biology						**15**
CO-405	**Module: Advanced Cell Biology I**				**m**	**3**	**5**
CO-405-A	From Cells to Tissues	Lecture	Written examination	Examination period			5
CO-407	**Module: Advanced Cell Biology Lab**				**m**	**3**	**5**
CO-407-A	Cellular Compartments	Lab	Laboratory report	During the semester			5
CO-406	**Module: Advanced Cell Biology II**				**m**	**4**	**5**
CO-406-A	From Genes to Organisms	Lecture	Written examination	Examination period			5

	Constructor Track Modules (General Education)	Type	Assessment	Period	Status[1]	Sem.	CP
							15
	Unit: Methods						**10**
CTMS-MAT-07	**Module: Mathematical Concepts for the Sciences**				**m**	**1**	**5**
CTMS-07	Mathematical Concepts for the Sciences	Lecture	Written examination	Examination period			
CTMS-SCI-17	**Module: Physics for the Natural Sciences**				**m**	**2**	**5**
CTMS-17	Physics for the Natural Sciences	Lecture	Written examination	Examination period			
	Unit: German Language and Humanities (choose one module for each sememster)						**5**
	German is default language and open to Non-German speakers (on campus and online).[5]						
CTLA-	**Module: Language 1**				**me**	**1**	**2,5**
CTLA-	Language 1	Seminar	Various	Various	me		
CTLA-	**Module: Language 2**				**me**	**2**	**2,5**
CTLA-	Language 2	Seminar	Various	Various	me		
CTHU-HUM-001	**Humanities Module: Introduction to Philosophical Ethics**				**me**	**2**	**2,5**
CTHU-001	Introduction to Philosophical Ethics	Lecture (online)	Written examination	Examination period	me		
CTHU-HUM-002	**Humanities Module: Introduction to the Philosophy of Science**				**me**	**1**	**2,5**
CTHU-002	Introduction to the Philosophy of Science	Lecture (online)	Written examination	Examination period	me		
CTHU-HUM-003	**Humanities Module: Introduction to Visual Culture**				**me**	**2**	**2,5**
CTHU-003	Introduction to Visual Culture	Lecture (online)	Written examination	Examination period	me		
	Unit: Methods						**10**
	Module: Select from the following Methods modules offered in the Fall term or replace the mandatory elective (me) module (5 CP) with suitable CORE modules from other study programs.						
CTMS-SCI-19	**Module: Introduction to Bioinformatics**				**me[3]**	**3**	**5**
CTMS-19	Bioinformatics	Lecture	Written examination	Examination period			
CTMS-SCI-16	**Module: Analytical Methods**				**me[3]**	**3**	**5**
CTMS-16	Analytical Methods	Lecture	Written examination	Examination period			
CTMS-SCI-18	**Module: Plant Metabolism and Natural Products**				**m**	**4**	**5**
CTMS-18	Plant Metabolism and Natural Products	Lecture	Written examination	Examination period			
	Unit: New Skills						**5**
	Students must take a total 15-20 CP in New Skills modules in year 2 and 3						
CTNS-NSK- 01	**Module: Logic (perspective I)***				**me**	**3/5**	**2.5**
CTNS-01	Logic (perspective I)	Lecture (online)	Written examination	Examination period			
CTNS-NSK-02	**Module: Logic (perspective II)***				**me**	**3/5**	**2.5**
CTNS-02	Logic (perspective II)	Lecture (online)	Written examination	Examination period			
CTNS-NSK-03	**Module: Correlation and Causation (perspective I)***				**me**	**4/6**	**2.5**
CTNS-03	Correlation and Causation (perspective I)	Lecture (online)	Written examination	Examination period			
CTNS-NSK-04	**Module: Correlation and Causation (perspective II)***				**me**	**4/6**	**2.5**
CTNS-04	Correlation and Causation (perspective II)	Lecture (online)	Written examination	Examination period			
	*These modules are offered with two different perspectives, students may only select one						

Year 3 - CAREER								45
CA-INT-900	**Module: Internship / Startup and Career Skills**				**m**	**4/5**	**15**
CA-INT-900-0	Internship / Startup and Career Skills	Internship	Project report	During the 5th semester			15
CA-BCCB-800	**Module: Bachelor Thesis and Seminar BCCB**				**m**	**6**	**15**
CA-BCCB-800-T	Thesis BCCB	Thesis	Thesis	15th of May			12
CA-BCCB-800-S	Seminar BCCB	Seminar	Presentation	During the semester			3
	Unit: Specialization BCCB				**m**		**15**
	Take a total of 15 CP of specialization modules [4]						
CA-S-BCCB-801	**Specialization Module: Current Topics in Molecular Life Sciences**				**me**	**5**	**5**
CA-BCCB-801	Current Topics in Molecular Life Sciences	Seminar	Presentation	During the semester			
CA-S-BCCB-802	**Specialization Module: Experimental Strategy Design**				**me**	**5**	**5**
CA-BCCB-802	Experimental Strategy Design	Seminar	Portfolio Assessment	During the semester			
CA-S-BCCB-804	**Specialization Module: Biomedicine**				**me**	**6**	**5**
CA-BCCB-804	Biomedicine	Seminar	Poster Presentation	During the semester			
CA-S-xxx	**Specialization electives (see BCCB study program handbook)**				**me**	**5/6**	**5**

Total CP								
	Unit: New Skills							**10**
Students must take a total 15-20 CP in New Skills modules in year 2 and 3								
CTNS-NSK-05	**Module: Models, Matrices and Theories of Complex Systems**				**me**	**3/5**	**5**
CTNS-05	Models, Matrices and Theories of Complex Systems	Seminar (online)	Written examination	Examination period			
CTNS-NSK-06	**Module: Complex Problem Solving**				**me**	**3/5**	**5**
CTNS-06	Complex Problem Solving	Lecture (online)	Written examination	Examination period			
CTNS-NSK-07	**Module: Argumentation, Data Visualization and Communication***				**me**	**3/5**	**5**
CTNS-07	Argumentation, Data Visualization and Communication (perspective I)	Lecture (online)	Written examination	Examination period			
CTNS-NSK-08	**Module: Argumentation, Data Visualization and Communication***				**me**	**4/6**	**5**
CTNS-08	Argumentation, Data Visualization and Communication (perspective II)	Lecture (online)	Written examination	Examination period			
CTNS-NSK-09	**Module: Agency, Accountability & Leadership**				**me**	**4/6**	**5**
CTNS-09	Agency, Accountability & Leadership	Lecture (online)	Written examination	Examination period			
CTNS-CIP-10	**Module: Community Impact Project**				**me**	**3/5**	**5**
CTNS-10	Community Impact Project	Project	Project report	During the Sememster			
*These modules are offered with two different perspectives, students may only select one								
	Unit: Additional Methods							**5**
If you only take 15 CP of New Skills modules, you must then take one of the modules below								
CTMS-SKI-14	**Module: Programming in Python**				**me**	**5**	**5**
CTMS-14	Programming in Python	Lecture	Written examination	Examination period			
CTMS-21	**Module: Statistics and Data Analytics**				**me**	**6**	**5**
CTMS-21	Statistics and Data Analytics	Lecture	Written examination	Examination period			5
CTMS-SCI-19	**Module: Introduction to Bioinformatics**				**me**	**5**	**5**
CTMS-SCI-16	**Module: Analytical Methods**				**me**	**5**	**5**
								180

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

[2] For a full listing of all CHOICE / CORE / CAREER / CONSTRUCTOR Track modules please consult the **CampusNet online catalogue** and /or the study program handbooks.

[3] Module will be replaced with a CORE module from another study program in order to pursue a minor

[4] Note that 15 CP specialization modules need to be taken, of which a minimum of 10 CP must be major-specific and max. 5 CP can be major-related

[5] German native speakers will have alternatives to the language modules (in the field of Humanities).

Figure 3: Study and Examination Plan

5 Modules

5.1.1 General Biochemistry

Module Name	General Biochemistry
Module Code	2025-CH-100
Module ECTS	7.5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Sebastian Springer

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	1	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	1	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	1	Mandatory
2025-minor-BCCB Minor in BCCB	1	Mandatory

Student Workload	
Independent Study	90
Laboratory and Seminars	27.5
Laboratory Report Writing	24
Lecture	35
MSDS Preparation	4
Reading Lab Manuals	6
Safety Instructions	1
Total Hours	**187.5**

Module Components	**Number**	**Type**	**CP**
General Biochemistry Lab	CH-100-B	Laboratory	2.5
General Biochemistry	CH-100-A	Lecture	5

Module Description

The CHOICE General Biochemistry Module aims at students with a good High School knowledge of chemistry, mathematics, physics, and biology as well as basic self-directed study skills at high school level. The module consists of two module components, one lecture and one laboratory course.

In the lecture, students gain solid first-year level understanding of biochemistry and learn how to apply and analyze basic concepts of biochemistry.

In the laboratory course, students develop their practical skills and acquire basic proficiency in the use of laboratory equipment. The experiments parallel the lecture content and allow students to apply methods testing for the chemical properties of biomolecules. Furthermore, students learn how to document, describe, and discuss experimental data.

In both module components, students also acquire meta-skills such as self-organization and teamwork.

A single assessment type cannot sufficiently test all intended learning outcomes. The laboratory report evaluates experimental skills, whereas the written examination assesses understanding of theoretical knowledge, core principles, and analytical reasoning.

Recommended Knowledge

- High school level of chemistry, mathematics, physics and biology.

- For this module, students should revise chemistry, mathematics, physics and biology at the high school level and ideally bring basic self-directed study skills at the high school level.

- Students need to read the relevant chapters in the recommended textbooks and all course materials provided by the instructors (e.g., manuals for the laboratory course).

- For participation in the laboratory course, students must have attended the general safety instructions, fire safety instructions and the mandatory safety instructions to the laboratory course (chemical and S1 safety). In addition, Material Safety Data Sheets have to be prepared.

Usability and Relationship to other Modules

- The General Biochemistry Module provides an essential foundation for the study of BCCB.

- Provides an Introduction to Biotechnology

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain the chemical basics of the life sciences
2	Identify	Identify major classes of biological molecules
3	Describe	Describe the structure and function of proteins
4	Summarize	Summarize the basic principles of anabolic and energy metabolism
5	List	List the techniques and strategies in molecular life sciences
6	Relate	Relate gained knowledge and inductive reasoning to unknown topics in the molecular life sciences
7	Integrate	Integrate new scientific information into the framework of the knowledge already obtained
8	Perform	Perform basic experiments in a Biosafety Level S1 Laboratory
9	Follow	Follow experimental procedures outlined in a laboratory manual
10	Relate	Relate an experimental setup to the aim of an experiment
11	Formulate	Formulate expectations and hypotheses to be tested
12	Understand	Understand how different biomolecules can be analyzed by testing for their biochemical properties

13	Develop	Develop scientific writing skills regarding the depiction and description of experimental data as well as their interpretation in publication-style lab reports
14	Cite	Correctly cite literature and know how to avoid plagiarism

Indicative Literature

- Alberts et al Essential Cell Biology Garland latest edition
- Becker et al The World of the Cell Benjamin/Cummings Series in the Life Sciences latest edition
- General Introduction Manual and Lab Day Manuals provided by instructor
- Horton et al Principles of Biochemistry Prentice Hall latest edition

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
General Biochemistry Lab	Laboratory Report	Approx. 10 pages per report	33	45%	8-14
General Biochemistry	Written Examination	120 Minutes	67	45%	1-7

Module Achievement

To pass the module achievement, the average of six quizzes (one before each lab day) has to be 45% or higher. Apart from acquiring practical skills, each participant further needs to demonstrate sufficient understanding of the theoretical background underlying each experiment. Only with sufficient knowledge, students may claim authorship on the written reports submitted. If the average of all quizzes is lower than 45%, the students get the opportunity to write an individualized make-up exam during the examination period.

5.1.2 General Cell Biology

Module Name	General Cell Biology
Module Code	2025-CH-101
Module ECTS	7.5
Program Owner	2025-BCCB-BSc

	(Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Susanne Illenberger

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	2	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	2	Mandatory
2025-minor-BCCB Minor in BCCB	2	Mandatory

Student Workload	
Independent Study	75
Laboratory	27.5
Laboratory Report Writing	24
Lecture	35
MSDS Preparation	4
Reading Lab Manuals	6
Safety Instructions	1
Tutorial	15
Total Hours	**187.5**

Module Components	**Number**	**Type**	**CP**
General Cell Biology Lab	CH-101-B	Laboratory	2.5
General Cell Biology	CH-101-A	Lecture	5

Module Description

The CHOICE General Cell Biology Module introduces students to cells as the minimal functional units of life. The module consists of two module components, one lecture and one laboratory course:

The lecture focuses on the molecular architecture of cells and the general principles of cellular processes. Students learn how genetic information is encoded, organized, and inherited. They will explore how cellular compounds are synthesized, delivered, and degraded within the cell, and how these processes govern cellular physiology and communication. A comprehensive overview of the field of molecular cell biology will be provided through a combination of historical outlines, information about experimental approaches in the molecular life sciences and the analysis of key cellular processes including: DNA replication, protein synthesis, intracellular transport, cellular movements, cell division, Mendelian genetics, signal transduction, cellular communication, and the biology of neurons. Finally, students will learn how alterations in key molecules, e.g. by mutation, may lead to diseases, such as cancer and neurodegeneration.

The experiments in the laboratory course parallel the lecture content in that they introduce students to the molecular investigation of cells. Students will apply basic techniques to analyze genomic DNA

(nuclease treatment, PCR). The use of different modes of light microscopy will be introduced by observing movement and endocytosis in the ciliate Paramecium caudatum as well as the microscopic analysis of different muscle specimen. Furthermore, yeast cultures will be analyzed through cell counts and spectrophotometry.

In both module components, students also acquire meta-skills such as self-organization and teamwork.

A single assessment type cannot sufficiently test all intended learning outcomes. The laboratory report evaluates experimental skills, whereas the written examination assesses understanding of theoretical knowledge, core principles, and analytical reasoning.

Recommended Knowledge

- General understanding of biomolecules from the General Biochemistry lecture

- For this module, students should revise chemistry, mathematics, physics and biology at the high school level and ideally bring

basic self-directed study skills at the high school level.

Students need to read the relevant chapters in the recommended textbooks and all course materials provided by the

instructors (e.g., manuals for the laboratory course).

Students should participate in the weekly (voluntary) tutorials that accompany the lecture series.

For participation in the laboratory course, students must have attended the general safety instructions, fire safety instructions,

and the mandatory safety instructions to the laboratory course (chemical and S1 safety). In addition, Material Safety Data Sheets have to be prepared.

Usability and Relationship to other Modules

- The General Cell Biology Module provides an essential foundation for the study of BCCB.

Intended Learning Outcomes

No	Competence	ILO
1	Draw	Draw, label and describe cellular structures and processes
2	Recognize	Recognize cellular structures depicted by different modes of microscopy
3	Use	Use proper terminology and scientific language to explain cellular processes
4	Relate	Relate the class examples to more general principles governing cellular physiology
5	Provide	Provide examples for methodological approaches to investigate the molecular composition of cells and to monitor cellular processes.
6	Predict	Predict the outcome of simple experimental approaches in molecular cell biology

7	Apply	Apply their knowledge to solve more distantly related problems in molecular cell biology
8	Perform	Perform experiments in a Biosafety Level S1 Laboratory, partially under semi-sterile conditions
9	Show	Show practical laboratory skills (use of equipment, carry out methods etc.)
10	Follow	Follow experimental procedures in the fields of molecular cell biology as outlined in a laboratory manual
11	Use	Use technical equipment and plan basic experiments
12	Relate	Relate an experimental setup to the aim of an experiment
13	Formulate	Formulate expectations and hypotheses to be tested
14	Explain	Generally explain the principles of molecular biology and cellular analyses
15	Depict	Depict, describe, and interpret experimental data in publication-style lab reports
16	Cite	Correctly cite literature and know how to avoid plagiarism

Indicative Literature

- Alberts et al Molecular Biology of the Cell Garland Science latest edition
- General Introduction Manual and Lab Day Manuals provided by instructor
- Horton et al Principles of Biochemistry Prentice Hall latest edition
- Optional: Alberts et al Essential Cell Biology Garland latest edition
- Optional: Lodish et al Molecular Cell Biology Macmillan Education latest edition

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
General Cell Biology Lab	Laboratory Report	10 pages	33	45%	8-16
General Cell Biology	Written Examination	120 Minutes	67	45%	1-7

Module Achievement

To pass the module achievement, the average of six quizzes (one before each lab day) has to be 45% or higher. Apart from acquiring practical skills, each participant further needs to demonstrate sufficient understanding of the theoretical background underlying each experiment. Only with sufficient knowledge, students may claim authorship on the written reports submitted. If the average of all quizzes is lower than 45 %, the students get the opportunity to write an individualized make-up exam during the examination period.

5.1.3 General and Inorganic Chemistry

Module Name	General and Inorganic Chemistry
Module Code	2025-CH-120
Module ECTS	7.5
Program Owner	2025-CBT-BSc (Chemistry and Biotechnology)
Module Coordinator	Prof. Dr. Ulrich Kortz

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	1	Mandatory
2025-CBT-BSc **Chemistry and Biotechnology**	1	Mandatory
2025-minor-CBT **Minor in CBT**	1	Mandatory

Student Workload	
Independent Study (For Lecture)	75
Independent Study (For Laboratory)	41.5
Laboratory	26
Lecture	35
Tutorial	10
Total Hours	**187.5**

Module Components	**Number**	**Type**	**CP**
General and Inorganic Chemistry Lab	CH-120-B	Laboratory	2.5
General and Inorganic Chemistry	CH-120-A	Lecture	5

Module Description

This module provides a theoretical introduction to general and inorganic chemistry covering the areas of chemical foundations, atoms, molecules, ions, stoichiometry, types of chemical reactions and solution stoichiometry, gases, atomic structure and periodicity, bonding (general concepts), covalent bonding (orbitals), chemical equilibrium, acids and bases, and acid-base equilibria. Furthermore, students learn the practical foundation principles of chemistry, including basic laboratory techniques, the qualitative analysis of anions and cations, strong/weak acids and bases, titrations, the solubility of salts, crystallization, redox reactions, gravimetric analysis, volumetric analysis, complex formation, and the synthesis of nanoparticles.

A single assessment type cannot sufficiently test all intended learning outcomes. The laboratory report evaluates experimental skills, whereas the written examination assesses understanding of theoretical knowledge, core principles, and analytical reasoning.

Recommended Knowledge

Early reading, extensive note taking and self-testing, work through practice problems, and fully understand the material before entering the laboratory and the risks associated with the daily goals.

Usability and Relationship to other Modules

This module provides fundamental knowledge of chemistry and is a foundation for all other modules in CBT, BCCB, and MCCB

Intended Learning Outcomes

No	Competence	ILO
1	Discuss	Discuss basic concepts in general and inorganic chemistry
2	Recognize	Recognize general properties of matter
3	Engage	Engage in fundamental concepts in measurements and moles.
4	Identify	Identify basic types of chemical reactions
5	Perform	Perform stoichiometric calculations
6	Predict	Predict the general properties of gases
7	Understand	Understand elements and trends in the periodic table
8	Recognize	Recognize and discuss basic concepts of chemical bonding
9	Predict	Predict the reactivity of elements and compounds
10	Find	Find the locations and operating procedures of all safety equipment including the first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket
11	Use	Use lab equipment and be familiar with key aspects of working in a laboratory environment
12	Correlate	Correlate the theoretical concepts they learn in class and the actual experimental application of the various hypotheses, laws, techniques, materials, reactions, and instruments
13	Perform	Perform qualitative and quantitative determination of unknowns and know how to handle and analyze chemical compounds
14	Write	Write proper Laboratory Reports
15	Dispose	Properly dispose of chemical waste

Indicative Literature

- Course Handout
- Higson, Analytical Chemistry, Oxford University Press, 2005, or latest edition as appropriate, Parts 1 and 2.
- Jeffrey et.al., Vogel's Textbook of Quantitative Chemical Analysis, Longman Group UK Limited, 5th edition, 1989.
- Zumdahl and Zumdahl, Chemistry, 9th edition, Brooks Cole, 2014.

Entry Requirements

Prerequisites	None

Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
General and Inorganic Chemistry Lab	Laboratory Report	4-6 pages per report	33	45%	4, 5, 10-15
General and Inorganic Chemistry	Written Examination	120 Minutes	67	45%	1-9

Module Achievement

5.1.4 General Organic Chemistry

Module Name	General Organic Chemistry
Module Code	2025-CH-111
Module ECTS	7.5
Program Owner	2025-MCCB-BSc (Medicinal Chemistry and Chemical Biology)
Module Coordinator	Prof. Dr. Thomas Nugent

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	2	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	2	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	2	Mandatory

Student Workload	
Independent Study (For Lecture)	80
Independent Study (For Laboratory)	37
Laboratory	25.5
Lecture	35
Tutorial	10
Total Hours	**187.5**

Module Components	**Number**	**Type**	**CP**
General Organic Chemistry Lab	CH-111-B	Laboratory	2.5
General Organic Chemistry	CH-111-A	Lecture	5

Module Description

This module provides an introduction to Organic Chemistry and begins with general reactivity patterns and the supportive concepts of resonance, conjugation and aromaticity, which come from applying knowledge of orbitals. Carbanion, alcohol, and amine nucleophiles are introduced and this allows carbonyl additions resulting in: alcohol, acetal, imine, enamine, oxime, and harmacop formation to be discussed. The student is then exposed to the relationships between equilibria and rates of reaction to better understand mechanistic investigations. This is followed by an introduction to conformational analysis and stereochemistry which allow the transition states within the subsequent chapters on substitution, elimination, and addition reactions to be understood.

In a parallel manner, the student will learn that a chemistry laboratory is for exploring chemical reactions. However, before doing so we must demonstrate: safety aspects, common hazards, and the structure and content required for a laboratory report. After this, the essential techniques are shown for: setting up, monitoring (TLC, color change, etc.), and quenching (neutralize active chemicals)

reactions. In parallel, the student will purify the products (chromatography, crystallization, separatory funnel extractions, etc.), and use basic methods to identify the products. While doing so, the student is exposed to the common equipment (rotary evaporator, melting point apparatus, etc.) within the laboratory. Reactions based on nucleophilic substitution, elimination, bromination to an alkene, electrophilic aromatic substitution, and the isolation of a natural product, characterize the experimental exposure within this laboratory.

A single assessment type cannot sufficiently test all intended learning outcomes. The laboratory report evaluates experimental skills, whereas the written examination assesses understanding of theoretical knowledge, core principles, and analytical reasoning.

Usability and Relationship to other Modules

This module provides the foundation knowledge required for your 2nd year CORE modules

Recommended Knowledge

- Recognize organic functional groups

- familiar with orbitals

- exposed to the concept of equilibria

- laboratory safety and awareness

- Early reading, extensive note taking and self-testing, work through practice problems, fully understand the material before entering laboratory and the risks associated with the daily goals.

Intended Learning Outcomes

No	Competence	ILO
1	Understand	Understand bond strength and angles using knowledge of orbitals
2	Recognize	Recognize resonance effects versus inductive effects
3	Understand	Understand basic mechanisms and arrow pushing in organic chemistry
4	Differentiate	Differentiate some nucleophiles and electrophiles and their orbital connectivity to HOMO and LUMO concepts
5	Distinguish	Distinguish high and low energy conformations of molecules and recall their value for transition states
6	Identify	Identify basic symmetry elements, stereocenters, and be able to recognize the stereochemical outcome of selected reactions
7	Identify	Identify and recall specific structures and reactions discussed during class
8	Know	In addition to knowing the fire exit locations, students will be able to find the location and know the operating procedures of all safety equipment including the first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket in the laboratory
9	Handle	Handle and dispose of chemicals safely and show competence in locating and retrieving material safety data sheet (MSDS) information

10	Perform	Perform acid-base extractions
11	Monitor	Monitor and quench organic reactions
12	Identify	Identify standard laboratory equipment
13	Set up	Set up reactions with assistance

Indicative Literature

- J. Clayden, N. Greeves, S. Warren. Organic Chemistry, 2nd Edition, Oxford University Press, 2012.

Entry Requirements

Prerequisites	2025-CH-110 General Medicinal Chemistry and Chemical Biology **OR** 2025-CH-120 General and Inorganic Chemistry
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
General Organic Chemistry Lab	Laboratory Report	5-15 pages per report	33	45%	8-13
General Organic Chemistry	Written Examination	180 minutes	67	45%	1-7

Module Achievement

5.1.5 Microbiology

Module Name	Microbiology
Module Code	2025-CO-400
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Matthias Ullrich

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	3	Mandatory
2025-minor-BCCB Minor in BCCB	3	Mandatory

Student Workload	
Independent Study	75
Lecture	35
Tutorial	15
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Microbiology	CO-400-A	Lecture	5

Module Description

This Microbiology CORE module consists of one lecture.

There is no higher life form without microbes, but there are plenty of microbes without higher life forms. Microorganisms are present wherever life is possible. Microbes conduct the most diverse biochemical processes and are found anywhere in our natural and manmade surroundings. The lecture introduces principles of the world of microorganisms, discussing their diversity and analyzing how microbes act in the environment or on human health. Bacteria, archaea, fungi, protozoa, and viruses are dealt with in the context of human health, environmental processes, or food manufacturing. Taxonomy will be analyzed with respect to different characteristics, including presence and activity within various cellular compartments, or special biochemical features. The lecture addresses the diverse biochemical life styles of microbes from photosynthesis via biofilms and methanogenesis to pathogenicity. The role of microbes for the cycling of elements on our planet will be exemplarily demonstrated for carbon, nitrogen, and sulfur. Basic differences between microbes and their hosts will be delineated in order to equip students with knowledge about how to defeat microorganisms. The lecture furthermore deals with different ways to investigate and control microbial contaminations, and how microbes influence our everyday life, but also political processes and even social behavior.

Usability and Relationship to other Modules

This module builds on the pre-required BCCB CHOICE Modules General Biochemistry and General Cell Biology.

Recommended Knowledge

- Basic knowledge of biochemistry and cell biology.

- Students should have a sound background in biochemistry and cell biology that they acquired by attending the respective CHOICE modules. They should understand the basic structure and function of biomolecules and general principles by which cells multiply and interact with each other.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain the principles governing the world of microorganisms
2	Apply	Apply knowledge of biochemical and cellular processes to microbial metabolism
3	Illustrate	Illustrate the cellular interactions of microbes with their environment
4	Analyze	Analyze how pathogens cause diseases to infer the establishment of therapeutic strategies
5	Categorize	Categorize the diversity of microorganisms, their biochemical life styles, and microbial fitness.
6	Examine	Examine the characteristics of microbial habitats and establish differences between oxygenic and anoxygenic life processes
7	Determine	Determine cellular and environmental factors contributing to the evolutionary adaptions of microbes
8	Outline	Outline microbial biochemical cycles of elements such as oxygen, carbon, nitrogen, or sulfur

Indicative Literature

- Madigan et al Brock Biology of Microorganisms 15th Edition Pearson International 2018 or the latest edition as appropriate
- Various current research articles

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None

Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Microbiology	Written Examination	120 Minutes	100	45%	All intended learning outcomes

Module Achievement

5.1.6 Microbiology Lab

Module Name	Microbiology Lab
Module Code	2025-CO-408
Module ECTS	2.5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Matthias Ullrich

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory Elective

Student Workload	
Laboratory and Seminars	27.5
Laboratory Report Writing	28
Reading Lab Manuals	6
Safety Instructions	1
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Microbiology Lab	CO-408-A	Laboratory	2.5

Module Description

This Microbiology Lab Course CORE module consists of one laboratory course.

Microbial taxonomy and physiology will be analyzed with respect to different characteristics, including presence and activity within various environmental habitats, or special biochemical features. Students will learn how to sample, analyze, isolate, handle, characterize, and taxonomically identify unknown microorganisms using diverse classical and state-of-the-art molecular techniques. Focus will be placed on the cellular characteristics of bacterial organisms, their biochemical properties and capabilities, as well as their resistance towards antibiotics. For this, each student will be assigned to one microbial aquatic habitat, will have to take a sample, and process it individually. The participants will learn how to identify an unknown bacterium, how to determine its growth rate, and how to compare its taxonomic marker genes with genomic databases. The individual experimental results will be summarized in a manuscript-style lab report.

This module is intentionally designed as a 2.5 CP module to enhance Employability by exposing students to a variety of professionally relevant topics rather than requiring in-depth specialization.

Usability and Relationship to other Modules

This module builds on the pre-required BCCB CHOICE Modules General Biochemistry and General Cell Biology.

Recommended Knowledge

- Basic knowledge of biochemistry and cell biology

- Basic laboratory skills in biochemistry and cell biology

- S1 safety instructions

- Students should have a sound background in biochemistry and cell biology that they acquired by attending the respective CHOICE modules. Students should have acquired basic skills in experimental molecular biology techniques from the respective CHOICE laboratory courses.

Intended Learning Outcomes

No	Competence	ILO
1	Apply	Apply their theoretical knowledge to the skilled use of methods in microbiology and microbial biochemistry
2	Apply	Apply methods in microbiology and microbial biochemistry
3	Handle	Handle microorganisms in a sterile and safe manner.
4	Record	Record and transfer experimental data
5	Identify	Identify microorganisms
6	Master	Master classical and molecular tools to characterize microbes
7	Interpret	Interpret growth and resistance data for individual microbial organisms

Indicative Literature

- Laboratory manuals provided by the instructor
- Madigan et al Brock -Biology of Microorganisms 15th Edition Pearson International 2018 or the latest edition as appropriate

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs

Microbiology Lab	Laboratory Report	10 Pages per report	100	45%	All intended learning outcomes of the laboratory course

Module Achievement

5.1.7 Infection and Immunity

Module Name	Infection and Immunity
Module Code	2025-CO-401
Module ECTS	7.5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Sebastian Springer

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory Elective
2025-minor-BCCB Minor in BCCB	4	Mandatory Elective

Student Workload	
Independent Study	135
Lecture	52.5
Total Hours	**187.5**

Module Components	**Number**	**Type**	**CP**
Microbial Pathogenicity	CO-401-B	Lecture	2.5
Immunology	CO-401-A	Lecture	5

Module Description

Infectious diseases of all types have always been and still are a major threat to our civilization. Our immune system defends us against pathogens such as viruses, bacteria, worms, and fungi, and it also contributes to protection against cancer and other diseases. The module brings pathogenicity and immunity and their relationship into close context and enables a thorough understanding of the underlying complexities.

The human immune system is central to fighting disease. Immunology is thus one of the central sciences underlying medicine and at the same time a fascinating application of the principles of molecular life sciences to a complex organismic phenomenon. The Immunology lecture provides a second-year undergraduate-level introduction to the entire field of immunology that is based on knowledge in general biochemistry and cell biology. Students will get to know the molecular agents of the system (receptors and metabolic processes), with intracellular processes (antigen presentation and innate intracellular defense), cell-specific phenomena (cell differentiation, maturation, and trafficking), the function of the organs of the immune system, and organismic phenomena such as the acute phase response. The lecture then turns towards the mechanisms of disease and disease-specific immunity, focusing on autoimmunity, HIV infection, and cancer as three major examples. In addition,

pathogen evasion of the immune response is discussed as an important feature. Finally, immunotherapy approaches are thoroughly discussed. Altogether, the lecture enables students to understand the functioning of the immune system, its role in preventing, fighting, and (sometimes) causing diseases, as well as the possibilities that arise from the manipulation of the immune system through vaccination and adoptive transfer.

The Microbial Pathogenicity lecture will familiarize students with basic principles of microbial pathogenicity, methods used to investigate pathogens, and a selection of infectious diseases caused by microbes and viruses. The lecture is meant to explore potential ways to treat and heal infected individuals and how to utilize our knowledge of pathogens for the successful treatment of diseases. Aside of state-of-the-art methods on how to identify virulence and pathogenicity factors, the lecture will introduce specific examples of diseases and the pathogens that cause them. For each disease, the lecture will address the pathogen's discovery, how it employs virulence factors, how it infects and transmits, and how the respective infection can be treated. Students will learn how to distinguish between different types of microbial infections and will understand how the immune system copes with various types of infection both qualitatively and quantitatively. The Emerging problems of multiple antibiotic resistance will also be covered in this lecture. Ultimately, participants will appraise the role of microbial infections as global challenges for the future development of our human societies.

The module comprises two major content areas with distinct intended learning outcomes; separate written examinations allow each area to be assessed with sufficient depth and validity.

Usability and Relationship to other Modules

This module builds on the pre-required BCCB CHOICE Modules General Biochemistry and General Cell Biology.

Recommended Knowledge

- Basic knowledge in biochemistry and cell biology

- Basic self-directed study skills

- Students should have a sound background in biochemistry and cell biology that they acquired by attending the respective CHOICE modules. They should understand the basic structure and function of biomolecules, and the general principles by which cells multiply and interact with each other. Furthermore, students should have acquired basic skills in experimental molecular biology techniques from the respective CHOICE laboratory courses.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain the topics of the lecture at the level presented
2	Apply	Apply this understanding to relate the basic knowledge to current problems in research and medicine
3	Analyze	Analyze and discriminate immunological challenges posed by specific pathogens
4	Correlate	Correlate pathogen exposure with the characteristic answer of the immune system

5	Judge	Judge the success rates, likelihoods, and time lines of different immunological treatments currently available, in development, or being envisioned
6	Apply	Apply knowledge of biochemical and cellular processes to understand principles in infection biology
7	Analyze	Analyze infectious diseases, their principles and mechanisms
8	Evaluate	Evaluate the applicability of molecular methods to assess microbial pathogenicity
9	Distinguish	Distinguish between how bacteria, fungi, viruses or parasitic pathogen infect a host
10	Identify	Identify and investigate microbial pathogens and their role in symptom development
11	Prioritize	Prioritize measures on how to cope with a microbial infection
12	Correlate	Correlate basic principles of immunology and pathogenicity
13	Deduce	Deduce the impact of a virulence or pathogenicity factor on the functioning of the immune system
14	Outline	Outline basic steps on how to identify and treat a microbial infection

Indicative Literature

- Madigan et al Brock Biology of Microorganisms 15th Edition Pearson International 2018 or the latest edition as appropriate
- Murphy and Weaver Janeway's Immunobiology 9th edition Garland Science 2017 or the latest edition as appropriate
- Various research articles related to the individual infectious diseases and their pathogens

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Microbial Pathogenicity	Written Examination	60 Minutes	33	45%	All intended learning

					outcomes
Immunology	Written Examination	120 Minutes	67	45%	All intended learning outcomes of the module.

Module Achievement

5.1.8 Advanced Biochemistry I

Module Name	Advanced Biochemistry I
Module Code	2025-CO-402
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Susanne Illenberger

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	3	Mandatory Elective

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Metabolic Pathways	CO-402-A	Lecture	5

Module Description

The module intends to provide a detailed understanding of the biochemical reactions that underlie energy production and consumption in living systems. The thermodynamics and kinetics of ligand binding to proteins and enzyme catalysis are explained. The module will further introduce advanced methods to study the molecules involved in enzymatic catalysis. These concepts are applied to explain the principles of metabolism. In this context, the module describes how energy is produced by living organisms, and how key types of biomolecules are synthesized and degraded. Thus, all important classes of biomolecules are covered (with exception of DNA and RNA that are covered in Advanced Biochemistry II). A special focus will be placed on common schemes and the adjustment of metabolism under different cellular conditions. Note: Photosynthesis as a key metabolic pathway will be discussed in the module "Methods for Plant Metabolism and Natural Products".

Usability and Relationship to other Modules

This module builds on the pre required BCCB CHOICE Modules General Biochemistry and General Cell Biology.

Usability and Relationship to other Modules

It is a pre-requisite for the BCCB CORE modules Advanced Biochemistry Laboratory and Advanced Biochemistry II.

Recommended Knowledge

- Knowledge of biochemical compounds

- Ability to write chemical equations

- Revision of the module content of the pre-required CHOICE modules

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain advanced theoretical concepts of metabolism
2	Outline	Outline advanced biochemical experimental methods that provide an entry point into independent experimental work
3	Outline	Outline key biochemical pathways and selected reaction mechanisms
4	Predict	Predict the outcome of metabolic pathways under variable conditions
5	Solve	Solve thermodynamic equations qualitatively and quantitatively.
6	Apply	Apply their knowledge to novel problems
7	Find	Find, understand, and interpret additional specific information from the literature and web resources

Indicative Literature

- Nelson and Cox Lehninger Principles of Biochemistry Freeman Macmillan latest edition
- Stryer et al Biochemistry Freeman Macmillan latest edition

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Metabolic Pathways	Written Examination	120 Minutes	100	45%	1-7

Module Achievement

5.1.9 Advanced Biochemistry II

Module Name	Advanced Biochemistry II
Module Code	2025-CO-403
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Felix Jonas

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory Elective

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Molecular Genetics	CO-403-A	Lecture	5

Module Description

The module intends to provide a detailed understanding of the biochemical mechanisms that underlie the realization of genetic information in living systems. Initially, the focus lies on the structure, biosynthesis, and degradation of nucleotides and nucleic acids. Molecular mechanisms are elucidated, by which genetic information is regulated, controlled, and expressed in bacterial and eukaryotic cells, with an emphasis on replication, transcription, and translation. Furthermore, this module gives an insight in DNA damage and repair mechanisms and it introduces advanced concepts such as epigenetic regulation and control. Molecular mechanisms contributing to an altered use of genetic information in living systems are exemplified (e.g., homologous recombination, (alternative) splicing or chemical modifications, and processing of both, RNAs and proteins). Advanced methods to study these processes are introduced and examples of experimental results obtained by these methods are discussed. A special focus is placed on common principles and the cellular integration of regulatory processes governing these pathways.

Recommended Knowledge

- Knowledge of biochemical compounds
- Ability to write chemical equations
- Knowledge about metabolic principles

- Ability to determine kinetic and thermodynamic parameters

- Revision of the module content of the pre-required CORE module

Intended Learning Outcomes

No	Competence	ILO
1	Discriminate	Discriminate different types of nucleic acid structures and understand the spatial organization of genetic information in cells
2	Outline	Outline the flow and control of genetic information in living systems
3	Explain	Explain the mechanisms of replication, transcription and translation
4	Discriminate	Discriminate regulatory processes on the different levels of the flow of information
5	Outline	Outline advanced biochemical experimental methods that provide an entry point into independent experimental work
6	Interpret	Interpret experimental data obtained by these methods
7	Predict	Predict the outcome of information pathways under variable conditions
8	Summarize	Summarize epigenetic control mechanisms
9	Assess	Assess which repair mechanisms act on which type of DNA damage
10	Rate	Rate the impact of the different mechanisms acting in the altered use of genetic information
11	Apply	Apply their knowledge to novel problems
12	Find	Find, understand, and interpret additional specific information from the literature and web resources

Indicative Literature

- Nelson and Cox Lehninger Principles of Biochemistry Freeman Macmillan latest edition
- Stryer et al Biochemistry Freeman Macmillan latest edition

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Molecular Genetics	Written Examination	120 Minutes	100	45%	All

Module Achievement

5.1.10 Advanced Biochemistry Lab

Module Name	Advanced Biochemistry Lab
Module Code	2025-CO-404
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Sebastian Springer

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	4	Mandatory

Student Workload	
Independent Study	24
Laboratory	50
Laboratory Report Writing	34
MSDS Preparation	4
Reading Lab Manuals	6
Safety Instructions	2
Seminar	5
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Advanced Biochemistry Lab	CO-404-A	Laboratory	5

Module Description

Understanding the relationships between the structure, biochemical properties, and activity of biomolecules is at the core of the discipline of biochemistry. This module focuses on the activity and the biological roles of proteins. Students will isolate and purify proteins, conduct enzyme activity assays, determine enzyme kinetics, and study the actions of small molecules on proteins. Methods include spectrophotometry, fluorimetry, chromatography, and gel electrophoresis. Students document their results in publication-style reports.

Recommended Knowledge

- Basic self-directed study skills

- Basic laboratory skills in chemistry and biochemistry

- Advanced knowledge in biochemistry

- For this module, it is important that students already know and understand biochemistry at an advanced level, and general chemistry and cell biology at first year level. They also need to be able to analyze (and partially, create) logical connections between scientific contents.

- Students need to read the relevant Chapters in the recommended textbooks and all course materials provided by the instructors (e.g., manuals for the laboratory course).

Students must have attended the general safety instructions, fire safety instructions, and the mandatory safety instructions

to the laboratory course (chemical and S1 safety). In addition, Material Safety Data Sheets have to be prepared.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain and practically apply various techniques in the biochemistry laboratory
2	Perform	Perform all calculations required to prepare the experiments
3	Organize	Organize the laboratory workflow to be safe, equitable, and reproducible
4	Act	Act safely in the laboratory
5	Assess	Assess the method most suitable for a given scientific problem
6	Exchange	Exchange results, discuss them with their peers, and defend them in front of an audience
7	Write	Write up their results in a coherent laboratory report

Indicative Literature

- Laboratory Manuals (updated yearly)

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Advanced Biochemistry Lab	Laboratory Report	5 x 10 Pages	100	45%	All

Module Achievement

5.1.11 Advanced Cell Biology I

Module Name	Advanced Cell Biology I
Module Code	2025-CO-405
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Klaudia Brix

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	3	Mandatory

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
From Cells to Tissues	CO-405-A	Lecture	5

Module Description

This lecture builds on the CHOICE module "General Cell Biology" and intends to provide a detailed and advanced understanding of the complexity of cellular systems. The module will analyze the molecular architecture of cells, the regulation of key cellular processes and their integration in tissue formation and enabling physiological tasks of our bodily organs. In this context, protein folding, targeting, and trafficking will be evaluated. The principles of compartmentalization by biological membranes of eukaryotic cells will be explained by looking at certain cell types of different tissues and bodily organs. By way of introducing the physiology of multi-cellular organisms, a detailed understanding of the underlying molecular principles and cellular mechanisms that enable cells, tissues, and bodies to maintain their function will be of central interest in this lecture. Finally, the consequences of cellular alterations (e.g., loss of homeostasis, stress, failure of quality control) will be tested and biomedical implications will be integrated wherever possible.

Recommended Knowledge

- Basic knowledge of cell biology and biochemistry.

- Revision of the module content of the pre-required CHOICE modules.

- Visit the Molecular Life Sciences Seminar series in which researchers from other institutions give invited talks.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain key molecular mechanisms and regulatory processes in cell biology in detail
2	Identify	Identify specific cell types common or unique to specific tissues
3	Explain	Explain cellular interactions in tissues and organs
4	Examine	Examine tissue morphogenesis and organ functions for an advanced understanding of physiological bodily functions
5	Evaluate	Evaluate experimental designs used to answer key cell biological questions
6	Compare	Compare critically model systems used in cell biological research approaches.
7	Enhance	Enhance personal competence in abstracting complex data and devising scientific hypotheses

Indicative Literature

- Alberts et al Molecular Biology of the Cell Garland Science latest edition
- Mescher Junqueira's Basic Histology: Text and Atlas McGraw-Hill Companies Inc latest edition
- Pollard et al Cell Biology Saunders latest edition

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
From Cells to Tissues	Written Examination	120 Minutes	100	45%	All intended learning outcomes of the module.

Module Achievement

5.1.12 Advanced Cell Biology II

Module Name	Advanced Cell Biology II
Module Code	2025-CO-406
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Susanne Illenberger

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
From Genes to Organism	CO-406-A	Lecture	5

Module Description

This module builds on the CHOICE module "General Cell Biology" and the CORE module "Advanced Cell Biology I". In this lecture, students will apply their understanding of cellular processes to explain how these processes combine at the organismal level. First, the cellular energy status, proliferation, apoptosis, and cell communication will be analyzed at an advanced level, focusing on regulatory mechanisms that allow for the coordinated execution of these processes. In the context of early organismal development, the contribution of morphogens, homeotic genes and epigenetics in selected model organisms will be discussed. Secondly, students will learn how inherited traits define evolutionary fitness and how recombination and mutation contribute to evolution and natural selection. In the end, the current ideas about the evolution of the cell and the tree of life will be discussed.

Recommended Knowledge

- Basic knowledge of cell biology

- Basic knowledge of biochemistry

- Read the chapters in the recommended textbooks that cover the respective topics of the lecture (see syllabus)

- Read additional literature as indicated by instructor

- Visit journal clubs or lab meetings of research groups in the field of Molecular Life Science

- Attend the Molecular Life Sciences Seminar series

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain key molecular mechanisms and regulatory cellular processes in detail
2	Relate	Relate individual cellular processes to one another in early organismal development
3	Compare	Compare model systems used in developmental biology critically.
4	Correlate	Correlate alterations in molecular functions to consequences in organismal development
5	Explain	Explain the general principles underlying natural selection and evolution
6	Apply	Apply simple calculations to predict changes in allele frequency
7	Deduce	Deduce common principles in cell communication and regulation
8	Enhance	Enhance personal competence in abstracting complex cellular processes

Indicative Literature

- Alberts et al Molecular Biology of the Cell Garland Science latest edition
- Campbell et al Biology - A Global Approach (Global Edition) Pearson Education Ltd latest edition
- Graur Molecular and Genome Evolution Oxford University Press / Sinauer latest edition
- Nelson and Cox Lehninger Principles of Biochemistry Macmillan / Springer latest edition

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-101 General Cell Biology 2025-CO-405 Advanced Cell Biology I
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
From Genes to Organism	Written Examination	120 Minutes	100	45%	All

Module Achievement

5.1.13 Advanced Cell Biology Lab

Module Name	Advanced Cell Biology Lab
Module Code	2025-CO-407
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Klaudia Brix

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	3	Mandatory

Student Workload	
Independent Study	24
Laboratory	50
Laboratory Report Writing	34
MSDS Preparation	4
Reading Lab Manuals	6
Safety Instructions	2
Seminar	5
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Cellular Compartments	CO-407-A	Laboratory	5

Module Description

This module focuses on the cellular architecture and the subcellular targeting of proteins. The laboratory module has four major parts. CHO cells are transfected with plasmids coding for targeted and non-targeted green fluorescent protein (GFP). This part includes an introduction into cell culture techniques. Then, the localization of these proteins is investigated by microscopy and subcellular fractionation followed by SDS-PAGE and immunoblotting. In the third part, normal CHO cells are vital-stained and immunolabeled. Mouse tissue sections are immunolabeled for compartmental and cell surface proteins to include histological aspects of protein targeting and trafficking. Conventional and confocal fluorescence microscopy is employed to examine the microscopic specimen; image analysis tools will be used including quantitative cell biological approaches. The theoretical background of the experiments will be prepared by self-study of the laboratory manual and through compilation of material safety data sheets (MSDS). In-lab seminars will explain the theory behind the experiments and the expected outcomes. Trouble-shooting sessions will solve problems on the spot. The students will document and assess their experimental data in reports that follow the format of a scientific manuscript.

Recommended Knowledge

- Basic knowledge in general safety for experimental work in molecular life sciences laboratories

- S1 safety instructions

- Laser safety instructions

- MSDS preparation

- Mandatory attendance of biosafety instructions regarding S1 laboratories

- Mandatory attendance of laser safety instructions due to experimental work with a laser scanning microscope

- Mandatory preparation of material safety data sheets regarding specific chemicals used in the experiments

- Mandatory attendance of experiment-accompanying, imaging and lab report writing seminars during lab course time

- Visit lab meetings of research groups in the field of Molecular Life Science (voluntary)

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain key regulatory processes in cell biology
2	Discover	Discover the structure-function relationship of biomolecules at the cellular level
3	Gain	Gain detailed insight into the experimental analysis of cells on the practical level
4	Employ	Employ the regulatory framework of genetic engineering in the bioscience field
5	Test	Test research questions of protein targeting and trafficking experimentally.
6		Consider the basic principles of image analysis and quantitative cell biology
7	Enhance	Enhance personal competence in experimental skills in a research-oriented manner
8	Enhance	Enhance personal competence in reporting their own scientific data in publication-style laboratory reports

Indicative Literature

- Comprehensive Lab Manual provided by the instructor
- Literature list in lab manual

Entry Requirements

Prerequisites	2025-CH-100

	General Biochemistry 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Cellular Compartments	Laboratory Report	20 Pages	100	45%	All intended learning outcomes of the module.

Module Achievement

5.1.14 Experimental Strategy Design

Module Name	Experimental Strategy Design
Module Code	2025-CA-S-BCCB-802
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Susanne Illenberger

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective

Student Workload	
Independent Study	85
Lectures and plenary discussions	30
Research Group Meetings	5
Presentation	5
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Experimental Strategy Design	CA-BCCB-802	Lecture and Seminar	5

Module Description

One of the most challenging tasks in modern science is to design the optimal experimental strategy to unravel the fascinating complexity of biological systems. On one hand, this strategy may involve the isolation and characterization of a single molecule, while on the other hand it could require genetic manipulation and functional analysis of a whole organism. This module provides a problem-oriented introduction to the general design of hypothesis-driven research strategies in modern molecular life sciences. Research strategies will be developed based on the students' previous experiences and thus first discuss the methods that were already applied in second year BCCB modules and internships. Advanced State-of-the-Art methodology will be explored through the analysis of current scientific literature and flipped classroom approaches addressing experiment design and interpretation. In small groups, students will then outline their own experimental approach to experimentally analyze for a particular task or process towards the characterization of a novel protein (e.g., expression, cellular interactions, and cellular function). This also involves the formulation of a working hypothesis, the prediction of experimental outcomes and depiction of hypothetical results. The groups will present their experimental strategies and their "data" to the whole class for critical discussion at a separate “conference day” during the Reading and Examination period.

Recommended Knowledge

- Advanced knowledge in cell biology, molecular biology and biochemistry

- Ability to read and understand scientific literature

- Preferably basic research experience (e.g., from internship)

- Recapitulate the methods already applied in the BCCB laboratory modules.

- Recapitulate additional methodology (practical and theoretical) employed in the internship.

- Visit journal clubs or lab meetings of research groups in the field of Molecular Life Science

- Attend the Molecular Life Sciences Seminar series to experience how scientists present their data

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain routine and advanced methodology
2	Evaluate	Evaluate the advantages and limitations of different methods
3	Formulate	Formulate and test hypotheses for experimental research based on current knowledge and literature
4	Predict	Predict the experimental outcomes of experiments
5	Study	Study and critically analyze scientific literature.
6	Design	Design a coherent experimental strategy in Molecular Life Science
7	Present	Present experimental data in both, oral and written form
8	Enhance	Enhance personal competence in scientific discussion and academic writing

Indicative Literature

- Alberts et al Molecular Biology of the Cell Garland Science latest edition
- Nelson and Cox Lehninger Principles of Biochemistry Macmillan / Springer latest edition

Entry Requirements

Prerequisites	2025-CO-403 Advanced Biochemistry II 2025-CO-405 Advanced Cell Biology I 2025-CO-406 Advanced Cell Biology II
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Experimental Strategy Design	Portfolio Assessment (Quizzes, Programming Assignments)	In-class assignments (40%), Hypothesis development, description and data depiction (30%), oral presentation (30%); Please note that the portfolio assessment can only be repeated once.	100	45%	All

Module Achievement

5.1.15 Biomedicine

Module Name	Biomedicine
Module Code	2025-CA-S-BCCB-804
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Klaudia Brix

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	6	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	6	Mandatory Elective

Student Workload	
In-Class Discussions	9
Independent Study and Additional Readings	40
Lecture	26
Poster Design	49.5
Poster Presentation	0.5
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Biomedicine	CA-BCCB-804	Lecture and Seminar	5

Module Description

Biomedicine considers knowledge of key cellular processes that are often by affected in diseases, e.g. gene expression, cell proliferation, intracellular trafficking, signal transduction, and general the turnover of cellular compounds. This module will analyze how these processes become altered in different diseases, e.g., cancer and neurodegenerative diseases, and how diagnostic tools and therapies (ranging from chemical to natural compound- to cell-based approaches) can be developed according to a disease's molecular origin. The module will critically deduce the challenges in designing research projects aimed at translation to clinics, taking into consideration the societal context in a world with increasing cultural and socio-economic diversity. Environmental effects on disease onset and progression or decline will be considered in the discussion of e.g. endocrine disorders. The regulatory framework of activities in the bioscience field will be explained by including GMO-regulations, biosafety, and the ethical considerations of cloning, or establishing and using animal model systems of diseases. In addition, the production of recombinant proteins for substitution therapies and transgenic mouse models will be examined in detail.

Recommended Knowledge

- Advanced knowledge in cell biology

- Ability to read and understand scientific articles

- Critical discussion skills

- Read the chapters in the recommended textbooks that cover the respective topics of this lecture (see syllabus)

- Read about the diseases covered during this module in the Medline-Plus database (www.medlineplus.gov)

- Visit journal clubs or lab meetings of research groups in the field of Molecular Life Science

- Visit the Molecular Life Sciences Seminar series in which researchers from other institutions give invited talks

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain key regulatory processes in cell biology in detail
2	Explain	Explain possible mechanisms of disease
3	Understand	Understand diagnostics and therapy development
4	Employ	Employ the regulatory framework of activities in the bioscience field
5	Assess	Assess approaches in translational medicine critically.
6	Study	Study and critically interpret scientific articles
7	Present	Present other's data while critically discussing their graphical, verbal and oral depiction
8	Enhance	Enhance personal competence in communicating and validating scientific data in the form of poster design and presentation

Indicative Literature

- Alberts et al Molecular Biology of the Cell Garland Science latest edition
- McDonald Biology of Aging Garland Science latest edition
- Medline-Plus database and related literature cited therein at www.medlineplus.gov
- Pollard et al Cell Biology Elsevier latest edition
- Weinberg The Biology of Cancer Garland Science latest edition

Entry Requirements

Prerequisites	2025-CO-405 Advanced Cell Biology I 2025-CO-406 Advanced Cell Biology II

Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Biomedicine	Poster Presentation	30 minutes	100	45%	All intended learning outcomes of the module.

Module Achievement

5.1.16 Environmental Microbiology and Biotechnology

Module Name	Environmental Microbiology and Biotechnology
Module Code	2025-CA-S-CBT-804
Module ECTS	5
Program Owner	2025-CBT-BSc (Chemistry and Biotechnology)
Module Coordinator	Prof. Dr. Boran Kartal

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	6	Mandatory Elective

Student Workload	
Exam Preparation	35
Independent Study	45
Lecture and Presentations	45
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Environmental Microbiology and Biotechnology	CA-S-CBT-804	Lecture	5

Module Description

The topics of the Environmental Microbiology and Biotechnology module are the elemental cycles (Carbon, Nitrogen, Sulfur and Iron) that take place in nature. In these “cycles“ microorganisms, the most abundant living things on earth, convert different forms of elements to one and other [e.g. methane oxidizing bacteria oxidize methane (CH4) to carbon dioxide (CO2)]. In this module, the metabolic pathways that the microorganisms use to convert their substrates and the methodology to detect these microorganisms are described to the students in detail. Furthermore, the application of these microorganisms in wastewater treatment will be discussed.

Recommended Knowledge

- Basic knowledge of Microbiology, Molecular Biology, Biotechnology.

- Taking the CORE Modules Industrial Biotechnology (CBT) and Microbiology (BCCB) is helpful. Recall the contents of General Biochemistry Module.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain the biogeochemical processes within Carbon, Nitrogen, Sulphur and Iron cycles
2	Name	Name and classify the microorganisms responsible for the conversion of elements at different redox states (e.g. NO3- reduction to N2 or CH4 oxidation to CO2)
3	Describe	Describe the key types of energy metabolism of microorganisms (e.g. denitrification, photosynthesis, methanogenesis, fermentation, ammonium and methane oxidation, etc.)
4	Identify	Identify the impact of human activities on the natural cycles
5	Classify	Classify the biodiversity of prokaryotes and the evolutionary relations between ecologically relevant species including the current theories and concepts concerning microbial evolution
6	Compare	Compare and contrast conventional and advanced techniques that are used to detect microbiological activities in nature
7	Summarize	Summarize the most up-to-date developments in the field of microbiology
8	Read	Read and discuss scientific literature critically.

Indicative Literature

- Madigan et al Brock Biology of Microorganisms 15th edition Pearson 2018
- Nelson and Cox Lehninger Principles of Biochemistry 7th edition WH Freeman Macmillan Learning 2017

Entry Requirements

Prerequisites	2025-CH-100 General Biochemistry 2025-CH-120 General and Inorganic Chemistry 2025-CH-121 Introduction to Biotechnology: Microbiology and Genetics **OR** 2025-CO-400 Microbiology (for BCCB students)

Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Environmental Microbiology and Biotechnology	Written Examination	120 Minutes	100	45%	1-8

Module Achievement

5.1.17 Current Topics in the Molecular Life Sciences

Module Name	Current Topics in the Molecular Life Sciences
Module Code	2025-CA-S-BCCB-801
Module ECTS	5
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Sebastian Springer

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory Elective

Student Workload	
Independent Study	69
Lecture	10
Preparation Of Presentation	30
Presentation	45
Seminar	15
Total Hours	**169**

Module Components	**Number**	**Type**	**CP**
Current Topics in the Molecular Life Sciences	CA-BCCB-801	Seminar	5

Module Description

Cutting-edge science is complex and requires excellent communication and exchange of information among researchers. Communication in science takes many forms, some specific to science (such as the scientific manuscript or paper), and some shared with all academic disciplines (such as the engaging oral presentation of results or data). In this module, two specific forms, manuscripts and presentations, are explained in detail. Students will be taught how manuscripts are written and reviewed, and how scientific talks should be planned and structured. They will then organize the data from a high-impact scientific paper of their own choice into a slide show according to the rules of professional speaking.

Students will take the prepared slide file and turn it into a one-hour oral presentation. They will then be coached in successive sessions by the instructor, and by their own peers, to develop their own style of speaking and presenting. The entire class will then benefit from professional-level presentations of cutting-edge scientific literature of general interest.

Recommended Knowledge

- Advanced knowledge in cell biology

- Advanced self-directed study skills

- Basic presentation skills

- For this module, it is important that students already know and understand biochemistry and cell biology at the second-year level. They also need to be able to analyze (and partially, create) logical connections between scientific contents.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain how publications in the Molecular Life Sciences are structured
2	Explain	Explain how publications in the Molecular Life Sciences are put together and written by the authors
3	Explain	Explain how publications in the Molecular Life Sciences are pre-reviewed and how they undergo changes during the review process
4	Analyze	Analyze a scientific paper of their own choice in detail and how to evaluate its logical reasoning
5	Explain	Explain scientific experiments professionally and coherently to a professional audience.
6	Test	Test scientific conclusions for their logical rigor and discuss this with peers
7	Report	Report on some of the latest and most modern developments in the molecular life sciences
8	Present	Present scientific results (own or others') in front of an audience
9	Arrange	Arrange the contents of a scientific paper, and their own work, into a series of slides and to construct a 'story' that will keep an audience engaged
10	Plan	Plan an oral presentation for diverse audiences
11	Design	Design slides to explain a specific set of scientific contents
12	Give	Give a presentation at a professional level, which is useful for any kind of occupation where teaching, the exchange of ideas, and leadership are expected
13	Critique	Critique and to support the learning work of others (peer instruction)

Indicative Literature

- C Witt: Real Leaders Don't Do PowerPoint: How to Sell Yourself and Your Ideas Crown Business 2009 ISBN 978-0307407702
- G Reynolds: Presentation Zen Design New Riders Publications 2010 ISBN 978-0321934154 (Jacobs IRC HF571822 R49 2010)

- G Reynolds: Presentation Zen: Simple Ideas on Presentation Design and Delivery Addison-Wesley 3rd edition 2019 ISBN 978-0135800911 (Jacobs IRC HF571822 R49 2008)
- N Duarte: Slide:ology : the art and science of creating great presentations ISBN 978-0596522346 (Jacobs IRC HF571822 D83 2008)

Entry Requirements

Prerequisites	2025-CO-403 Advanced Biochemistry II 2025-CO-406 Advanced Cell Biology II **OR** 2025-CO-420 Medicinal Chemistry 2025-CO-421 Chemical Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Current Topics in the Molecular Life Sciences	Presentation	45 minutes	100	45%	All intended learning outcomes of the module.

Module Achievement

5.1.18 Neurobiology of Behavior

Module Name	Neurobiology of Behavior
Module Code	2025-CO-683
Module ECTS	5
Program Owner	2025-ISCP-BA (Integrated Social and Cognitive Psychology)
Module Coordinator	Prof. Dr. Ben Godde

Study Semester		
Program	**Semester**	**Status**
2025-ISCP-BA Integrated Social and Cognitive Psychology	3	Mandatory Elective
2025-Minor-Cog-Psych-BA Minor Cognitive Psychology	3	Mandatory
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Neurobiology of Behavior II	CO-683-B	Lecture	2.5
Neurobiology of Behavior I	CO-683-A	Lecture	2.5

Module Description

This module introduces state-of-the-art knowledge of structure-function relationships in the mammalian nervous system, particularly at the large-scale systems level. Starting from the organization of neural systems and the neuroanatomy of the brain, this module focuses on the neurobiological basis of cognitive processing in the areas of perception, motor control, attention, emotion, memory, learning, and language, etc. How do neurons communicate? What do drugs do to the brain and how do they alter behavior? How is the brain involved in making decisions? How does the brain change? These and other questions as well as critical perspectives are addressed in this module.

With a clear focus on the human brain, the module provides a basic review of the brain as a biological organ, including its basic structure and operations, and teaches students how the brain gives rise to a wide variety of complex behaviors. You will learn how to integrate knowledge obtained from several levels of analysis â€“ neurons, circuits, systems â€“ into a coherent understanding of the brainâ€™s structure and function. Thus, this module, lays the groundwork for other modules in psychology that relate behavior to underlying neural mechanisms. You will learn to evaluate the challenges and limits of modern, neuro-oriented psychology.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain the brain's basic structure and processes
2	Describe	Describe how brain structures and functions relate to psychological processes, phenomena, and behaviors
3	Evaluate	Evaluate the neuroscience approach to psychology critically.

Indicative Literature

- Breedlove SM & Watson NV (2017) Behavioral Neuroscience 8th ed Sunderland: Sinauer
- Kolb B & Wishaw IQ (2015)Fundamentals of Human Neuropsychology 7th ed New York: Worth Publishers

Entry Requirements

Prerequisites	2025-CH-340 Essentials of Cognitive Psychology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Neurobiology of Behavior II					
Neurobiology of Behavior I	Written Examination	120 Minutes	100	45%	All

Module Achievement

5.1.19 Neuroscience Methods

Module Name	Neuroscience Methods
Module Code	2025-CO-684
Module ECTS	5
Program Owner	2025-ISCP-BA (Integrated Social and Cognitive Psychology)
Module Coordinator	Prof. Dr. Ben Godde

Study Semester		
Program	**Semester**	**Status**
2025-ISCP-BA Integrated Social and Cognitive Psychology	3	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective

Student Workload	
Independent Study	90
Seminar/Laboratory	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Neuroscience Methods Lab	CO-684-B	Laboratory	2.5
Neuroscience Methods	CO-684-A	Seminar	2.5

Module Description

In neurobiology and cognitive psychology, respectively, a vast array of methods exists for investigating neuropsychological processes from single cells up to complex human behavior. Apart from basic research, these methods are very important in clinical investigations. Both in terms of methods that enable researchers to analyze processes (e.g. structural and functional neuroimaging, magnetoencephalography) and of techniques for manipulating processes (e.g. brain stimulation, optogenetic methods), fundamental new techniques have been developed recently.

Based on this, a thorough overview of available methods and their specific purposes is essential. With a strong focus on human brain imaging and electrophysiology, this module provides you with both practical skills and the conceptual knowledge to responsibly choose modern human brain imaging techniques for specific research or diagnostics purposes and to critically discuss their application potential as revealed by seminal or recent publications in the field.

The assessments target different ILOs for the two components. While the term paper is a critical reflection of the content and format of the mandatory presentation in the seminar component, the lab report reveals the skill level of the students in the application of methods learned in the lab component.

Intended Learning Outcomes

No	Competence	ILO
1	Choose	Choose and apply appropriate methods to answer specific research questions
2	Interpret	Interpret empirical results in the context of the chosen methods
3	Draw	Draw implications for further research from specific findings
4	Assess	Assess and compare critically the advantages and disadvantages of selected techniques.

Indicative Literature

- Kolb B & Wishaw IQ (2015)Fundamentals of Human Neuropsychology 7th ed Chapter 7: Imaging the brain's activity New York: Worth Publishers

Entry Requirements

Prerequisites	2025-CH-340 Essentials of Cognitive Psychology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Neuroscience Methods Lab	Laboratory Report	1,500 Words	50	45%	Intended learning outcomes of the lab (1)
Neuroscience Methods	Term Paper	1500 Words	50	45%	2-4

Module Achievement

Giving a presentation is pre-requisite prior to submission of the term paper.

5.1.20 Scientific Software and Databases

Module Name	Scientific Software and Databases
Module Code	2025-CO-443
Module ECTS	5
Program Owner	2025-CBT-BSc (Chemistry and Biotechnology)
Module Coordinator	Prof. Dr. Elke Nevoigt

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	4	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory Elective

Student Workload	
Independent Study and Homework	90
Lecture	20
Seminar	15
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Scientific Software and Databases	CO-443-A	Lecture	5

Module Description

The students will be familiarized with software to visualize scientific information in chemistry and life sciences. They will be familiarized with the sources used to draw the relevant scientific information, and the retrieval of primary sources of data. They will be familiarized with software to present results, and with software to numerically evaluate data. In the first class, details about the portfolio assessment will be further explain.

Recommended Knowledge

First-year modules in General Chemistry, Organic Chemistry, Biochemistry, and Biotechnology.

Usability and Relationship to other Modules

Module can be replaced with a CORE module from another study program in order to pursue a minor.

Intended Learning Outcomes

No	Competence	ILO
1	Use	Use software to write reports and scientific papers
2	Use	Use software to evaluate and handle numerical data
3	Use	Use software to present data graphically
4	Use	Use Entrez as a source of information on the life sciences
5	Use	Use software to draw chemical structures
6	Use	Use SciFinder to find information on research subjects, chemical structures and substructures, reactions to and from given structures, and patents
7	Use	Use the Cambridge Data System to retrieve data on crystal structures
8	Use	Use software to visualize data for small molecules
9	Use	Use PDB to retrieve and three-dimensionally visualize data on protein structures and interactions
10	Use	Use software to visualize protein structures and the interaction of small molecules with proteins
11	Use	Use GenBank to retrieve information on gene sequences and the similarities between genes
12	Use	Use metabolic data banks to retrieve information on metabolic pathways
13	Use	Use data banks to obtain information about clinical trials
14	Use	Use data banks to obtain data on toxicity and the side effects of drugs
15	Retrieve	Retrieve the primary sources of information of such data

Indicative Literature

- Handout provided by instructor

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Scientific Software and Databases	Portfolio Assessment	Active In-class participa	100	45%	1-15

		tion, Assignments [individual/group]			

Module Achievement

5.1.21 Industrial Biotechnology

Module Name	Industrial Biotechnology
Module Code	2025-CO-441
Module ECTS	5
Program Owner	2025-CBT-BSc (Chemistry and Biotechnology)
Module Coordinator	Prof. Dr. Elke Nevoigt

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	3	Mandatory
2025-minor-CBT Minor in CBT	3	Mandatory

Student Workload	
Exam Preparation	35
Independent Study	45
Lecture	45
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Industrial Biotechnology	CO-441-A	Lecture	5

Module Description

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 that are increasingly pushed by the chemical industry in order to achieve a more sustainable production of bulk and fine 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, students will be introduced to 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 the production of the above mentioned compounds.

Usability and Relationship to other Modules

The module Industrial Biotechnology is complementary to the Advanced Biotechnology Lab and synergistic to the Specialization course Environmental Microbiology and Biotechnology.

Intended Learning Outcomes

No	Competence	ILO
1	Evaluate	Evaluate the use of renewable as opposed to fossil resources as raw materials for chemical production
2	Explain	Explain the impact of using enzymes and cells in the chemical and pharmaceutical industry
3	Evaluate	Evaluate the value and applications of industrial enzymes
4	Express	Express the concept of a cell factory
5	List	List important commercial products made by microorganisms
6	Assess	Assess the limitations of natural organisms for chemical production
7	Evaluate	Evaluate the feasibility of a bio-based process compared to its chemical counterpart
8	Identify	Identify possibilities to modify the characteristics of an enzyme
9	Sketch	Sketch the basic concept of metabolic engineering

Indicative Literature

- Glazer and Nikaido Microbial Biotechnology: Fundamentals of Applied Microbiology2nd edition Cambridge University Press 2007
- Lehninger Principles of Biochemistry: International Edition WH Freeman 2017
- Madigan et al Brock Biology of Microorganisms 15th edition Pearson International 2018
- Ratledge and Kristiansen Basic Biotechnology 3rd edition Cambridge University Press 2006
- Schmidt Pocket Guide for Biotechnology and Genetic Engineering 2003
- Willey et al Prescott's Microbiology 11th edition McGraw-Hill Education 2019

Entry Requirements

Prerequisites	2025-CH-121 Introduction to Biotechnology: Microbiology and Genetics **OR** 2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs

Industrial Biotechnology	Written Examination	120 Minutes	100	45%	1-9

Module Achievement

5.1.22 Chemical Biology

Module Name	Chemical Biology
Module Code	2025-CO-421
Module ECTS	5
Program Owner	2025-MCCB-BSc (Medicinal Chemistry and Chemical Biology)
Module Coordinator	Prof. Dr. Klaudia Brix Prof. Dr. Thomas Nugent

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory
2025-minor-MCCB Minor in MCCB	4	Mandatory

Student Workload	
Independent Study	80
Lecture	35
Tutorial	10
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Chemical Biology	CO-421-A	Lecture	5

Module Description

Chemical biology combines the fields of chemistry and biology. In particular, chemical techniques such as targeted drug design and small molecule synthesis are applied to study and interfere with biological systems. In such approaches, the aim is to analyze, quantify and modify regulatory mechanisms of cellular and organ systems. Therefore, a general understanding of physiological processes is crucial. This module will focus on cellular decision making by enzymes that mediate biological processes and enable cellular functions as diverse as cell differentiation, proliferation, tissue regeneration, and cell death. The group of enzymes chosen are the hundreds of proteolytic enzymes that enable the most important post-translational modification, proteolysis. Proteases are critical - vital or deadly - from the beginning of life until its end they regulate the cell cycle, they involve in developmental processes, and they bring about catabolism. Proteolytic cleavages allow the activation and inactivation of cellular programs through the maturation, activation, inactivation, or destruction of the key molecules involved. Proteases are involved in as many diseases as molecules exist, and because their action is irreversible, they are prime targets to treat diseases with pharmaceutical drugs. From bench to bedside will be the over-arching theme of this module. In keeping with this notion, G protein-coupled receptors

constitute another important group of molecules that have more recently been targeted in pharmacology. The use of biologics is another recent paradigm shift in the treatment of diseases and pharmaceutical exploitation. These topics will be discussed in order to broaden the understanding of the application aspects of medicinal chemistry and chemical biology.

Recommended Knowledge

- Basic knowledge in biochemistry, cell biology, and organic chemistry

- Understanding of structure-function relationships at the molecular and cellular levels

- Read the chapters in the recommended textbooks that cover the respective topics of this lecture course (see syllabus)

- Attend the lab meetings of research groups in the Department of Life Sciences and Chemistry

- Visit the Molecular Life Sciences Seminar series in which researchers from other institutions are invited to give talks

Usability and Relationship to other Modules

- It is complementary to the Biomedicine module of the BCCB major.

- This module complements the thematics noted within the CORE modules: Medicinal Chemistry and Pharmaceutical Chemistry.

- One of three default second year CORE modules for a minor in MCCB.

Intended Learning Outcomes

No	Competence	ILO
1	Explain	Explain physiological mechanisms and organ functions
2	Understand	Understand how to tackle disease by interfering with irreversible biological processes
3	Interfere	Interfere with biological processes that involve signaling by GPCRs.
4	Identify	Identify diseases that are brought about by alterations in enzymes or caused by altered signaling pathways
5	Understand	Understand molecular targeting by drugs based on protein structure
6	Understand	Understand how diseases are treated with pharmaceutical reagents that inhibit enzymes
7	Distinguish	Distinguish the challenges and chances that arise when choosing a drug target to be exploited for clinical application
8	Discuss	Discuss critically experimental design to answer key research questions.
9	Build	Abstract complex data for building scientific hypotheses

Indicative Literature

- K. Brix, W. Stöcker. Proteases: Structure and Function, Springer, 2013, ISBN 978-3-7091-1939-6.

Entry Requirements

Prerequisites	2025-CH-110 General Medicinal Chemistry and Chemical Biology 2025-CH-111 General Organic Chemistry
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Chemical Biology	Written Examination	180 minutes	100	45%	All

Module Achievement

5.1.23 Drug Discovery

Module Name	Drug Discovery
Module Code	2025-CA-S-MCCB-805
Module ECTS	2.5
Program Owner	2025-MCCB-BSc (Medicinal Chemistry and Chemical Biology)
Module Coordinator	Prof. Dr. Björn Windshügel

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory Elective

Student Workload	
Independent Study	45
Lecture	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Drug Discovery	CA-S-MCCB-805	Lecture	2.5

Module Description

Drug discovery is a multidisciplinary process that historically requires ten or more years to bring a drug to market. The drug discovery value chain can be divided into pre-clinical and clinical phases, and the subdivisions of each will be discussed. Within those discussions, an important theme will be target identification and validation, which will be covered in detail. The most important techniques for identifying bioactive small molecules will also be presented for different types of drug targets using relevant case study examples. Furthermore, pre-clinical processes such as hit-to-lead development and ADME (absorption, distribution, metabolism, excretion) properties assessment are delineated. Finally, the progression and importance of typical clinical trials will be covered (phase I-III) and this is complemented with the critical points required for regulatory approval.

Usability and Relationship to other Modules

This module is for students who continue to be curious and want to extend their studies within the field of drug discovery and may considering graduate level education in Life Sciences or Medicinal Chemistry.

Intended Learning Outcomes

No	**Competence**	**ILO**

1	Explain	Explain the overall process of drug discovery.
2	Summarize	Summarize the challenges of the drug discovery process.
3	Plan	Plan an early-stage drug discovery study for a given target.
4	Assess	Assess the validity of a potential drug target.
5	Interpret	Interpret the outcome of a screening campaign.
6	Recommend	Recommend strategies for characterizing bioactive small molecules.
7	Select	Select the best candidate compound to be progressed in clinical trials.

Indicative Literature

- Benjamin Blass: Basic Principles of Drug Discovery and Development Academic Press 2nd edition 2021
- Raymond G Hill Humphrey P rang: Drug Discovery and Development: Technology in Transition Churchill Livingstone 2nd edition 2012
- Rick Ng: Drugs: From Discovery to Approval Wiley-Blackwell 3rd edition 2015

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Drug Discovery	Written Examination	90 minutes	100	45%	All

Module Achievement

5.1.24 Synthetic Biology

Module Name	Synthetic Biology
Module Code	2025-CA-S-MCCB-804
Module ECTS	5
Program Owner	2025-MCCB-BSc (Medicinal Chemistry and Chemical Biology)
Module Coordinator	Dr. Andreas M. Lisewski

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	6	Mandatory Elective

Student Workload	
Independent Study	80
Lecture	35
Tutorial	10
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Synthetic Biology	CA-S-MCCB-804	Seminar	5

Module Description

Assuming elementary knowledge in molecular and cell biology the students will learn the basic elements of molecular biology (such as DNA replication, transcription, translation) from a modern information engineering perspective that incorporates the transmission of genetic information from a sender to a receiver (communication theory at a molecular biology level). This allows a representation of the basic concepts of synthetic biology using a hierarchy of abstraction through parts, modules, devices, and sender-receiver systems. We then critically discuss several landmark experimental realizations of this hierarchy during the "golden decade" of synthetic biology, from the 2000s to 2010s, including genetic logic gates, engineered genetic and metabolic networks, and synthetic genomes or even entire cells. A subtheme is additionally placed on the technological risks and societal impacts that come from breakthroughs in synthetic biology.

Recommended Knowledge

- Molecular and cell biology main concepts

- Review the elementary concepts of Molecular and Cell Biology.

Usability and Relationship to other Modules

- Complements and further advances General Cell Biology and Advanced Cell Biology I and II (BCCB)

- Partly complements Bioprocess Engineering and Chemical and Pharmaceutical Technology (CBT)

Intended Learning Outcomes

No	Competence	ILO
1	Identify	Identify and explain basic concepts in synthetic biology by collecting and assessing appropriate items from the primary literature
2	Schematize	Schematize, differentiate and discuss parts, modules, and devices in synthetic biology systems
3	Conclude	Conclude that parts, modules, and devices predispose synthetic biological systems to rational (re-)design and engineering
4	Identify	Identify information codes, redundancy and errors (noise) in synthetic biology systems
5	Break down	Break down today's main directions in synthetic biology, present their landmark experiments, and formulate specific technical challenges in their experimental realizations.
6	Assess	Assess, compare, and rank inherent risks (e.g., from individual to public health, to entire human society) associated with synthetic biology

Indicative Literature

- Cameron, D., Bashor, C. & Collins, J. A brief history of synthetic biology. Nat Rev Microbiol 12(5):381-390 (2014) https://doi.org/10.1038/nrmicro3239
- Meng, F., Ellis, T. The second decade of synthetic biology: 2010–2020. Nat Commun 11(1):5174 (2020). https://doi.org/10.1038/s41467-020-19092-2
- Synthetic Biology - A Primer (Revised Edition), Geoff Baldwin, Published 2016; ISBN 978-1783268795

Entry Requirements

Prerequisites	2025-CH-101 General Cell Biology
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs

Synthetic Biology	Oral Examination	40 minutes	100	45%	1-6

Module Achievement

The module achievement ensures that a sufficient level of synthetic biology knowledge has been obtained before attempting the oral exam. The module achievement therefore requires completing an academic presentation of a current synthetic biology topic provided and to answer scientific questions related to the chosen topic. In order to obtain the module achievement (and to sit for the final exam), it is necessary to submit the written presentation document, to deliver in front of the class the presentation, and to discuss relevant questions asked during the presentation. The module achievement, considered fulfilled when these necessary activities have been accomplished no later than the day before the final exam, is on a pass/non pass basis, and does not impact the overall module grade. A block of activities can be offered in January to make up for missed module achievement activities and deliverables.

5.1.1 Internship / Startup and Career Skills

Module Name	Internship / Startup and Career Skills
Module Code	2025-CA-INT-900
Module ECTS	15
Program Owner	Career (Career Module for UG programs)
Module Coordinator	Dr. Tanja Woebs Clémentine Senicourt

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	5	Mandatory
2025-CS-BSc Computer Science	5	Mandatory
2025-ECE-BSc Electrical and Computer Engineering	5	Mandatory
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	5	Mandatory
2025-F-ACS-BSc Applied Computer Science	5	Mandatory
2025-IBA-BA International Business Administration	5	Mandatory
2025-IRPH-BA International Relations: Politics and History	5	Mandatory
2025-ISCP-BA Integrated Social and Cognitive Psychology	5	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory
2025-MDDA-BSc Management, Decisions and Data Analytics	5	Mandatory
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory
2025-PHDS-BSc Physics and Data Science	5	Mandatory
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	6	Mandatory
2025-CS-BSc Computer Science	6	Mandatory
2025-ECE-BSc	6	Mandatory

Electrical and Computer Engineering		
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	6	Mandatory
2025-GEM-BA Global Economics and Management	6	Mandatory
2025-IBA-BA International Business Administration	6	Mandatory
2025-IRPH-BA International Relations: Politics and History	6	Mandatory
2025-ISCP-BA Integrated Social and Cognitive Psychology	6	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	6	Mandatory
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	6	Mandatory
2025-PHDS-BSc Physics and Data Science	6	Mandatory
2025-RIS-BSc Robotics and Intelligent Systems	6	Mandatory
2025-S-ACS-BSc Applied Computer Science	6	Mandatory
2025-SDT-BSc Software, Data and Technology	6	Mandatory

Student Workload	
Internship	308
Internship Event	2
Independent Study	32
Interactive Learning	33
Total Hours	**375**

Module Components	**Number**	**Type**	**CP**
Internship	CA-INT-900-0	Internship	15

Module Description

The aims of the internship module are reflection, application, orientation, and development: for students to reflect on their interests, knowledge, skills, their role in society, the relevance of their major subject to society, to apply these skills and this knowledge in real life whilst getting practical experience, to find a professional orientation, and to develop their personality and in their career. This module supports the programs' aims of preparing students for gainful, qualified employment and the development of their personality.

The full-time internship must be related to the students' major area of study and extends lasts a minimum of two consecutive months, normally scheduled just before the 5th semester, with the internship event and submission of the internship report in the 5th semester. Upon approval by the SPC and SCS, the internship may take place at other times, such as before teaching starts in the 3rd semester or after teaching finishes in the 6th semester. The Study Program Coordinator or their faculty delegate approves the intended internship a priori by reviewing the tasks in either the Internship Contract or Internship Confirmation from the respective internship institution or company. Further regulations as set out in the Policies for Bachelor Studies apply.

Students will be gradually prepared for the internship in semesters 1 to 4 through a series of mandatory information sessions, seminars, and career events.

The purpose of the Career Services Information Sessions is to provide all students with basic facts about the job market in general, and especially in Germany and the EU, and services provided by the Student Career Support.

In the Career Skills Seminars, students will learn how to engage in the internship/job search, how to create a competitive application (CV, Cover Letter, etc.), and how to successfully conduct themselves at job interviews and/or assessment centers. In addition to these mandatory sections, students can customize their skill set regarding application challenges and their intended career path in elective seminars.

Finally, during the Career Events organized by the Career Service Center (e.g. the annual Constructor Career Fair and single employer events on and off campus), students will have the opportunity to apply their acquired job market skills in an actual internship/job search situation and to gain their desired internship in a high-quality environment and with excellent employers.

As an alternative to the full-time internship, students can apply for the StartUp Option. Following the same schedule as the full-time internship, the StartUp Option allows students who are particularly interested in founding their own company to focus on the development of their business plan over a period of two consecutive months. Participation in the StartUp Option depends on a successful presentation of the student's initial StartUp idea. This presentation will be held at the beginning of the 4th semester. A jury of faculty members will judge the student's potential to realize their idea and approve the participation of the students. The StartUp Option is supervised by the Faculty StartUp Coordinator. At the end of StartUp Option, students submit their business plan. Further regulations as outlined in the Policies for Bachelor Studies apply.

The concluding Internship Event will be conducted within each study program (or a cluster of related study programs) and will formally conclude the module by providing students the opportunity to present on their internships and reflect on the lessons learned within their major area of study. The purpose of this event is not only to self-reflect on the whole internship process, but also to create a professional network within the academic community, especially by entering the Alumni Network after graduation. It is recommended that all three classes (years) of the same major are present at this event to enable networking between older and younger students and to create an educational environment for younger students to observe the "lessons learned" from the diverse internships of their elder fellow students.

Recommended Knowledge

- Information provided on CSC

- Major specific knowledge and skills

- Please see the section “Knowledge Center” at JobTeaser Career Center for information on Career Skills seminar and workshop offers and for online tutorials on the job market preparation and the application process. For more information, please see https://constructor.university/student-life/career-services

- Participating in the internship events of earlier classes

Usability and Relationship to other Modules

This module applies skills and knowledge acquired in previous modules to a professional environment and provides an opportunity to reflect on their relevance in employment and society. It may lead to thesis topics.

Intended Learning Outcomes

No	Competence	ILO
1	Describe	Describe the scope and the functions of the employment market and personal career development.
2	Apply	Apply professional, personal, and career-related skills for the modern labor market, including self-organization, initiative and responsibility, communication, intercultural sensitivity, team and leadership skills, etc.
3	Manage	Manage their own career orientation processes independently by identifying personal interests, selecting appropriate internship locations or start-up opportunities, conducting interviews, succeeding at pitches or assessment centers, negotiating related employment, managing their funding or support conditions (such as salary, contract, funding, supplies, work space, etc.).
4	Apply	Apply specialist skills and knowledge acquired during their studies to solve problems in a professional environment and reflect on their relevance in employment and society.
5	Justify	Justify professional decisions based on theoretical knowledge and academic methods.
6	Reflect	Reflect on their professional conduct in the context of the expectations of and consequences for employers and their society.
7	Reflect	Reflect on and set their own targets for the further development of their knowledge, skills, interests, and values.
8	Establish	Establish and expand their contacts with potential employers or business partners, and possibly other students and alumni, to build their own professional network to create employment opportunities in the future.
9	Discuss	Discuss observations and reflections in a professional network.

Indicative Literature

Entry Requirements

Prerequisites	2025-CA-INT-900 Internship / Startup and Career Skills At least 15 CP from CORE modules in the major
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Internship	Project Report	3500 words	100	Pass/Fail	1-9

Module Achievement

5.1.1 Bachelor Thesis and Seminar BCCB

Module Name	Bachelor Thesis and Seminar BCCB
Module Code	2025-CA-BCCB-800
Module ECTS	15
Program Owner	2025-BCCB-BSc (Biochemistry and Cell Biology)
Module Coordinator	Prof. Dr. Sebastian Springer

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory

Student Workload	
Independent Study	104
Scientific Project Work	200
Seminar	21
Writing	50
Total Hours	**375**

Module Components	**Number**	**Type**	**CP**
Seminar BCCB	CA-BCCB-800-S	Seminar	3
Thesis BCCB	CA-BCCB-800-T	Project	12

Module Description

In the Seminar and Thesis BCCB Module, students carry out scientific work in the final semester of the BCCB study program. The scientific work includes both the completion of a scientific project with a host principal investigator as well as the critical and thorough assessment of own and others' scientific work in the frame of a seminar setting with presentations and discussions. Data analyses and interpretation will be according to good scientific practice and ethical standards. With this, the Seminar and Thesis BCCB Module is an essential demonstration of the scientific skills that students have acquired during their study of BCCB. Furthermore, it also serves to prepare students for any further study (Master, PhD degrees) as well as work in a science-related environment. Even for students who aim to follow careers in finance, journalism, law, or consulting (to name but a few), the first-hand knowledge of the scientific process is a crucial educational component and a career-building element.

Usability and Relationship to other Modules

The Seminar and Thesis BCCB Module takes place in the final semester of the BCCB study program. It is usable for all further study, especially Master and PhD programs.

Recommended Knowledge

- Advanced skills in Biochemistry and Cell Biology

- Advanced self-directed study skills

- Basic presentation skills

- To begin the Seminar and Thesis BCCB Module, it is essential that students have advanced skills in biochemistry and cell biology. This is achieved by having taken the mandatory CORE modules in Advanced Biochemistry and Advanced Cell Biology. It is also important for students to have self-directed study skills and basic presentation skills.

- Identify an area or a topic of interest and discuss this with your prospective supervisor in good time.

- Create a research proposal including a research plan to ensure timely submission.

- Review the University's Code of Academic Integrity and Guidelines to Ensure Good Academic Practice.

Intended Learning Outcomes

No	Competence	ILO
1	Evaluate	Evaluate critically experiments performed by others in terms of scientific consistency, actual process planning, the appropriateness of experimental controls, reproducible execution, interpretation, and embedding in the scientific literature
2	Evaluate	Evaluate the planning of their own project in view of these criteria
3	Integrate	Integrate any critique to improve their own project
4	Present	Present their work in front of an audience of experts working on similar topics
5	Apply	Apply science ethics with respect to their own work and that of others
6	Compose	Compose a completed piece of work using scientific methods, i.e., a Bachelor thesis
7	Conduct	Conduct thorough and cutting-edge literature searches in support of a specific project
8	Plan	Plan a scientific project
9	Implement	Individually implement a scientific project using acquired time and project management skills
10	Write	Write up a scientific project in a coherent, concise and logical way
11	Evaluate	Evaluate their own performance in projecting, composing, planning, implementing, and concluding a scientific project
12	Evaluate	Evaluate situations and make decisions based on ethical considerations, and adhere to and defend ethical, scientific, and professional standards
13	Summarize	Summarize the process of scientific knowledge generation

Indicative Literature

Entry Requirements

Prerequisites	2025-CA-BCCB-800 Bachelor Thesis and Seminar BCCB Students must have taken and successfully passed a total of at least 30 CP from advanced modules, and of those, at least 20 CP from advanced modules in the major.
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Seminar BCCB	Presentation	45 minutes	20	45%	1-5
Thesis BCCB	Thesis	20 Pages	80	45%	6-13

Module Achievement

6 Constructor Track Modules

6.1 Methods Modules

6.1.1 Mathematical Concepts for the Sciences

Module Name	Mathematical Concepts for the Sciences
Module Code	2025-CTMS-MAT-07
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Keivan Mallahi Karai Prof. Dr. Joachim Vogt

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	1	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	1	Mandatory
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	1	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	1	Mandatory

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Mathematical Concepts for the Sciences	CTMS-07	Lecture	5

Module Description

In this module, students develop and strengthen quantitative problem-solving skills that are important in the natural sciences. Hands-on exercises and group work are integrated in the lectures to maximize feedback between the students and the instructor. The module starts with a review of elementary mathematical concepts such as functions and their graphs, units and dimensions, and series and convergence. Vectors and matrices are introduced using linear equations, and then motivated further in the context of basic analytical geometry. An extended section on calculus proceeds from basic

differentiation and integration to the solution of differential equations, always guided by applications in the natural sciences. The module is concluded by a data-oriented introduction to descriptive statistics and basic statistical modeling applied to laboratory measurements and observations of natural systems.

Recommended Knowledge

Review basic mathematical concepts and tools.

Usability and Relationship to other Modules

- The module is a mandatory / mandatory elective module of the Methods and New Skills area that is part of the

Constructor Track (Methods and New Skills modules; Language and Humanities modules).

- Mandatory for a major in BCCB, CBT, EES, and MCCB

- Elective for all other study programs.

Intended Learning Outcomes

No	Competence	ILO
1	Identify	Identify important types of quantitative problems in the natural sciences
2	Select	Select and use key solution strategies, methods, and tools
3	Explain	Explain and apply linear algebra concepts and techniques
4	Analyze	Analyze models and observations of natural systems using derivatives and integrals
5	Classify	Classify differential equations, find equilibria, and apply standard solution methods
6	Process	Process data by means of descriptive statistics and basic regression techniques

Indicative Literature

- D Cherney T Denton A Waldron (2013 June) Linear Algebra Retrieved from: https://wwwmathucdavisedu/~linear/
- E N Bodine S Lenhart and L J Gross (2014) Mathematics for the Life Sciences Princeton: Princeton University Press
- KF Riley MP Hobson and SJ Bence (2002) Mathematical methods for physics and engineering Cambridge: Cambridge University Press
- M Corral Vector Calculus (2008) Retrieved from: http://wwwmecmathnet/calc3bookpdf

Entry Requirements

Prerequisites	None
Co-requisites	None

Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Mathematical Concepts for the Sciences	Written Examination	120 Minutes	100	45%	1-6

Module Achievement

6.1.2 Physics for the Natural Sciences

Module Name	Physics for the Natural Sciences
Module Code	2025-CTMS-SCI-17
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Jürgen Fritz

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	2	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	2	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	2	Mandatory

Student Workload	
Independent Study and Homework	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Physics for the Natural Sciences	CTMS-17	Lecture	5

Module Description

Physics is the most fundamental of all natural sciences and serves as a basis for other sciences and engineering disciplines. This module introduces non-physics majors to the basic principles, facts, and experimental evidence from physics, as it is needed especially for the life sciences, geosciences, and chemistry.

Emphasis is placed on general principles and general mathematical concepts for a basic understanding of physical phenomena. Basic mathematics (geometry, calculus, vector analysis) is used to develop a quantitative and scientific description of physical phenomena. A voluntary tutorial is offered to discuss homework or topics of interest in more detail.

The lecture provides an overview of the basic fields of physics such as mechanics (motion, force, energy, momentum, oscillations, fluid mechanics), thermodynamics (temperature, heat, 1st law, ideal gas and kinetic gas theory, thermodynamic processes, entropy), electromagnetism (charge, electric field, potential, current, magnetic field, induction), optics (oscillations, waves, sound, reflection and refraction, lenses and optical instruments, interference and diffraction), and modern physics (particle-wave duality, atoms and electrons, absorption and emission, spin, NMR, ionizing radiation, radioactivity).

Recommended Knowledge

- High school math

- Basic high school physics

- Review high school math (especially calculus, geometry and vector analysis) and high school physics (basics of motion, forces and energy). Level and content follows the along standard textbooks for calculus-based first year general university physics, such as Young & Freedman: University Physics; Halliday, Resnick & Walker: Fundamentals of Physics; or others.

Intended Learning Outcomes

No	Competence	ILO
	Apply	Apply basic calculus, geometry, and vector analysis for a quantitative description of physical systems
	Apply	Apply basic problem-solving strategies from physics to test the plausibility of ideas or arguments, such as reducing different natural phenomena to their underlying physical principles, or using analogies, approximations, estimates or extreme cases
	Recall	Recall the basic facts and experimental evidence in mechanics, thermodynamics, electromagnetism, optics and modern physics
	Use	Use the basic concepts of motion, force, energy, oscillations, heat, and light to describe natural and technical phenomena

Indicative Literature

- Halliday Resnick Walker Fundamentals of Physics Extended Version Wiley latest edition
- Young & Freedman University Physics with Modern Physics Pearsson latest edition
- Zinke-Allmang et al Physics for the Life Sciences Nelson Education latest edition

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Physics for the Natural Sciences	Written Examination	120 Minutes	100	45%	1-4

Module Achievement

6.1.3 Introduction to Bioinformatics

Module Name	Introduction to Bioinformatics
Module Code	2025-CTMS-SCI-19
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Felix Jonas Prof. Dr. Marc-Thorsten Hütt

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory Elective

Student Workload	
Class Attendance	35
Exam Preparation	10
Independent Study	80
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Introduction to Bioinformatics	CTMS-19	Lecture and Exercises	5

Module Description

Bioinformatics has become an indispensable backbone of modern research in biology and medicine. With this course we want to provide an overview of current bioinformatics approaches, ranging from sequence analysis to biological databases and networks. An emphasis is on describing both, the biological applications of such methods as well as the underlying mathematical and algorithmic concepts. The Python programming language will be used to illustrate these concepts.

The theoretical aspects of the lecture will be complemented by hands-on problem-solving exercises that amount to at least 30% of the in-class time. As such, the final examination will have a corresponding fraction of practical problem-solving components.

Recommended Knowledge

It is recommended that students install a recent stable version of Python on their notebooks and familiarize themselves with Jupyter notebooks as a programming environment.

Intended Learning Outcomes

No	**Competence**	**ILO**

	Access	Access and use the main bioinformatics databases
	Apply	Apply standard and current bioinformatics tools
	Delineate	Delineate the main principles and the relevance of algorithmic approaches
	Explain	Explain the limitations and parameter dependences of these tools

Indicative Literature

- Arthur M Lesk Introduction to Bioinformatics Oxford University Press 2013
- Hütt M Dehnert M Methoden der Bioinformatik 2nd edition Springer-Verlag 2016
- Please see CampusNet entry for further details
- R Durbin S Eddy A Krogh G Mitchison Biological sequence analysis - Probabilistic models of proteins and nucleic acids CU Press 1998
- S Choudhuri Bioinformatics for Beginners: Genes Genomes Molecular Evolution Databases and Analytical Tools Academic Press 2014 and recent scientific literature

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Introduction to Bioinformatics	Written Examination	120 Minutes	100	45%	All intended learning outcomes of the module.

Module Achievement

To pass the module achievement, the average of 10 homework assignments has to be 45% or higher. The homework assignments help students acquire practical skills beyond what can be assessed in a written exam. If the average of all homework assignment is lower than 45 %, the students get the opportunity to write an individualized make-up exam during the examination period.

6.1.4 Analytical Methods

Module Name	Analytical Methods
Module Code	2025-CTMS-SCI-16
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Nikolai Kuhnert

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	3	Mandatory
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	3	Mandatory

Student Workload	
Independent Study	80
Lecture	35
Tutorial	10
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Analytical Methods	JTMS-16	Lecture	5

Module Description

Analytical science is an important applied area of all chemical and life sciences. Analytical science 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 the identification and quantification of chemical compounds. It provides the methods and toolbox for all experimental sciences. 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 for scientists at the interface to the life sciences. The course will give an introduction to analytical chemistry with selected applications. This will include an introduction to analytical terms and definitions, basic statistic treatment of experimental data, qualitative and quantitative analysis and instrumental analysis with an 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 introduced. A series of lectures covering application in drug analysis, clinical chemistry, forensics, and toxicology will complement the course.

Usability and Relationship to other Modules

It complements the Analytical Chemistry laboratory course and provides the experimental tool box for all fields of chemistry and the associated life sciences.

Recommended Knowledge

- Basic knowledge in Life Sciences

- Students should have a sound background knowledge in general chemistry and MCCB as well as organic chemistry acquired by attending the respective CHOICE courses. They should have understood the basic principles of chemical bonding and chemical structures as well as the basic concepts of quantification and experimental measurement.

Intended Learning Outcomes

No	Competence	ILO
1	Illustrate	Illustrate knowledge of instrumental methods including spectroscopic techniques and separation techniques
2	Explain	Explain and understand physical principles behind spectroscopic techniques and separation techniques and apply them to practically-orientated issues
3	Apply	Apply knowledge of instrumental techniques to solve qualitative and quantitative analytical problems
4	Interpret	Interpret spectroscopic data and deduce chemical structures from these data
5	Compare	Compare spectroscopic data and predict spectral properties from chemical structures
6	Calculate	Calculate quantitative values from analytical results
7	Plan	Plan analytical experiments to solve chemical problems
8	Calculate	Calculate and estimate errors in analytical procedures by applying statistical methods
9	Test	Test scientific hypotheses
10	Prepare	Prepare scientific reports and critical analysis on experimental findings of analytical results

Indicative Literature

- Clayden Greeves Warren Organic Chemistry 2nd Edition 2012 (ISBN 978-0-19-927029-3)
- PW Atkins Physical Chemistry 9th edition 2006 (ISBN 9780198700722)
- R Kellner J Mermet M Otto M Valcarel M Widmer Analytical Chemistry: A Modern Approach to Analytical Science 2nd ed 2004(ISBN: 978-3-527-30590-2)

Entry Requirements

Prerequisites	None
Co-requisites	None

Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Analytical Methods	Written Examination	180 minutes	100	45%	1-10

Module Achievement

6.1.5 Plant Metabolism and Natural Products

Module Name	Plant Metabolism and Natural Products
Module Code	2025-CTMS-SCI-18
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Matthias Ullrich

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory
2025-CBT-BSc Chemistry and Biotechnology	4	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory

Student Workload	
Independent Study	90
Lecture	35
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Plant Metabolism and Natural Products	CTMS-18	Lecture	5

Module Description

Understanding general principles of biochemical processes in living cells requires a rigorous and robust knowledge of nature's ways and capacities to form and use primary and secondary metabolites from inorganic materials via the autotrophic (producer) mode of algae and plants. This module introduces methods to assess and understand the breath-taking diversity of plant biochemical and cellular processes, plant metabolism, as well as plant-borne substances including their purposes and functions. An array of compounds produced by plants that are relevant to human health and nutrition will be introduced. This is done by demonstrating natural functions of biomolecules in plant metabolism or during regulation of biochemical processes. Methods to assess and quantify photosynthesis and the Calvin cycle will be introduced, as will be those needed to understand the phytohormone-based language of plants. State-of-the-art methods on how to analyze the fascinating types of interactions with other organisms is explained. Plant genetic engineering is introduced, and its methodology are explained in detail. Modern aspects of agriculture, food production, and the application of natural products in medicine will complete this methods survey of plant metabolism and natural products.

Recommended Knowledge

- Comprehensive high school knowledge of chemistry, mathematics, physics, biochemistry, and cell biology

- Students should have a sound background knowledge in chemistry, mathematics, physics, biochemistry and cell biology.

- Read the chapter “Plant Form and Function” (Joanne Chory) in the recommended textbook of Neil A. Campbell and Jane B. Reece, BIOLOGY, Benjamin Cummings, Pearson Education, current edition.

Usability and Relationship to other Modules

- It complements the non-photosynthesis learning components of BCCB’s general education. It furthermore provides essential background knowledge for medicinal chemistry, chemical biology, chemistry, and biotechnology.

- For CBT major students: the module can be replaced with a CORE module from another study program to pursue a minor.

Intended Learning Outcomes

No	Competence	ILO
1	Apply	Apply knowledge of biochemical and cellular processes to understand principles in the world of plants and algae
2	Illustrate	Illustrate a plant's basic metabolic and biochemical features of plants
3	Describe	Describe plant cells and plant tissue characteristics
4	Explain	Explain how photosynthesis and the Calvin cycle enable autotrophic life
5	Delineate	Delineate how plants interact with their biotic and abiotic environment
6	Explain	Explain the basic principles of Environmental Biochemistry
7	Classify	Classify plant hormones, their roles, and the importance of their homeostasis
8	Interpret	Interpret the bioactivity potential of natural products
9	Outline	Outline processes in plant biochemistry and plant genetics
10	Describe	Describe natural product biosynthesis
11	Illustrate	Illustrate how plants use basic building blocks to create complex structures
12	Relate	Relate biological activities of natural products with their use for medicinal purposes
13	Transfer	Transfer the acquired knowledge to novel natural products
14	Explain	Explain the importance of functional groups in natural products for bioactivity

Indicative Literature

- Buchanan, Biochemistry and Molecular Biology of Plants, Wiley, latest edition.
- Madigan et.al., Brock Biology of Microorganisms, latest edition.
- Urry et. al., Campell Biology, Pearson, latest edition.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Plant Metabolism and Natural Products	Written Examination	120 Minutes	100	45%	1-14

Module Achievement

6.2 New Skills

6.2.1 Logic (perspective I)

Module Name	Logic (perspective I)
Module Code	2025-CTNS-NSK-01
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Marina Christodoulou

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory Elective
2025-CBT-BSc **Chemistry and Biotechnology**	3	Mandatory Elective
2025-CS-BSc Computer Science	3	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	3	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	3	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	3	Mandatory Elective
2025-GEM-BA Global Economics and Management	3	Mandatory Elective
2025-IBA-BA International Business Administration	3	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	3	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	3	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	3	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	3	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	3	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	3	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	3	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	3	Mandatory Elective

2025-RIS-BSc Robotics and Intelligent Systems	3	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	3	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	4	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	4	Mandatory Elective
2025-S-ACS-BSc Applied Computer Science	4	Mandatory Elective

Student Workload	
Independent Study	27.5
Online Lecture	17.5
Tutorials	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Logic (perspective I)	CTNS-01	Lecture (Online)	2.5

Module Description

Suppose a friend asks you to help solve a complicated problem? Where do you begin? Arguably, the first and most difficult task you face is to figure out what the heart of the problem actually is. In doing that you will look for structural similarities between the problem posed and other problems that arise in different fields that others may have addressed successfully. Those similarities may point you to a pathway for resolving the problem you have been asked to solve. But it is not enough to look for structural similarities. Sometimes relying on similarities may even be misleading. Once you've settled tentatively on what you take to be the heart of the matter, you will naturally look for materials, whether evidence or arguments, that you believe is relevant to its potential solution. But the evidence you investigate of course depends on your formulation of the problem, and your formulation of the problem likely depends on the tools you have available - including potential sources of evidence and argumentation. You cannot ignore this interactivity, but you can't allow yourself to be hamstrung entirely by it. But there is more. The problem itself may be too big to be manageable all at once, so you will have to explore whether it can be broken into manageable parts and if the information you have bears on all or only some of those parts. And later you will face the problem of whether the solutions to the particular sub problems can be put together coherently to solve the entire problem taken as a whole.

What you are doing is what we call engaging in computational thinking. There are several elements of computational thinking illustrated above. These include: Decomposition (breaking the larger problem down into smaller ones); Pattern recognition (identifying structural similarities); Abstraction (ignoring irrelevant particulars of the problem): and Creating Algorithms), problem-solving formulas.

But even more basic to what you are doing is the process of drawing inferences from the material you have. After all, how else are you going to create a problem-solving formula, if you draw incorrect

inferences about what information has shown and what, if anything follows logically from it. What you must do is apply the rules of logic to the information to draw inferences that are warranted.

We distinguish between informal and formal systems of logic, both of which are designed to indicate fallacies as well as warranted inferences. If I argue for a conclusion by appealing to my physical ability to coerce you, I prove nothing about the truth of what I claim. If anything, by doing so I display my lack of confidence in my argument. Or if the best I can do is berate you for your skepticism, I have done little more than offer an ad hominem instead of an argument. Our focus will be on formal systems of logic, since they are at the heart of both scientific argumentation and computer developed algorithms. There are in fact many different kinds of logic and all figure to varying degrees in scientific inquiry. There are inductive types of logic, which purport to formalize the relationship between premises that if true offer evidence on behalf of a conclusion and the conclusion and are represented as claims about the extent to which the conclusion is confirmed by the premises. There are deductive types of logic, which introduce a different relationship between premise and conclusion. These variations of logic consist in rules that if followed entail that if the premises are true then the conclusion too must be true.

There are also modal types of logic which are applied specifically to the concepts of necessity and possibility, and thus to the relationship among sentences that include either or both those terms. And there is also what are called deontic logic, a modification of logic that purport to show that there are rules of inference that allow us to infer what we ought to do from facts about the circumstances in which we find ourselves. In the natural and social sciences most of the emphasis has been placed on inductive logic, whereas in math it is placed on deductive logic, and in modern physics there is an increasing interest in the concepts of possibility and necessity and thus in modal logic. The humanities, especially normative discussions in philosophy and literature are the province of deontic logic.

This module will also take students through the central aspects of computational thinking, as it is related to logic; it will introduce the central concepts in each, their relationship to one another and begin to provide the conceptual apparatus and practical skills for scientific inquiry and research.

This 2.5 CP module supports Academic Excellence by providing essential contextual knowledge that underpins the program's qualification aims, while appropriately limiting academic depth relative to the core technical competencies of the field

Intended Learning Outcomes

No	Competence	ILO
1	Apply	Apply the various principles of logic and expand them to computational thinking.
2	Understand	Understand the way in which logical processes in humans and in computers are similar and different at the same time.
3	Apply	Apply the basic rules of first-order deductive logic and employ them rules in the context of creating a scientific or social scientific study and argument.
4	Employ	Employ those rules in the context of creating a scientific or social scientific study and argument.

Indicative Literature

- Frege, Gottlob (1879), Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens [Translation: A Formal Language for Pure Thought Modeled on that of Arithmetic],Halle an der Salle: Verlag von Louis Nebert.
- Gödel, Kurt (1986), Russels mathematische Logik. In: Alfred North Whitehead, Bertrand Russell: Principia Mathematica. Vorwort, S. V–XXXIV. Suhrkamp.
- Kubica, Jeremy. Computational fairy tales. Jeremy Kubica, 2012.
- Leeds, Stephen. "George Boolos and Richard Jeffrey. Computability and logic. Cambridge University Press, New York and London1974, x+ 262 pp." The Journal of Symbolic Logic 42.4 (1977): 585-586.
- McCarthy, Timothy. "Richard Jeffrey. Formal logic: Its scope and limits. of XXXVIII 646. McGraw-Hill Book Company, New York etc. 1981, xvi+ 198 pp." The Journal of Symbolic Logic 49.4 (1984): 1408-1409.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Logic (perspective I)	Written Examination	60 Minutes	100	45%	All

Module Achievement

6.2.2 Logic (perspective II)

Module Name	Logic (perspective II)
Module Code	2025-CTNS-NSK-02
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Jules Coleman

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	3	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	3	Mandatory Elective
2025-CS-BSc Computer Science	3	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	3	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	3	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	3	Mandatory Elective
2025-GEM-BA Global Economics and Management	3	Mandatory Elective
2025-IBA-BA International Business Administration	3	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	3	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	3	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	3	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	3	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	3	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	3	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	3	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	3	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	3	Mandatory Elective

2025-RIS-BSc Robotics and Intelligent Systems	3	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	3	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	4	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	4	Mandatory Elective
2025-S-ACS-BSc Applied Computer Science	4	Mandatory Elective

Student Workload	
Independent Study	45
Online Lecture	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Logic (perspective II)	CTNS-02	Lecture (Online)	2.5

Module Description

The focus of this module is on formal systems of logic, since they are at the heart of both scientific argumentation and computer developed algorithms. There are in fact many kinds of logic and all figure to varying degrees in scientific inquiry. There are inductive types of logic, which purport to formalize the relationship between premises that if true offer evidence on behalf of a conclusion and the conclusion and are represented as claims about the extent to which the conclusion is confirmed by the premises. There are deductive types of logic, which introduce a different relationship between premise and conclusion. These variations of logic consist in rules that if followed entail that if the premises are true then the conclusion too must be true.

This module introduces logics that go beyond traditional deductive propositional logic and predicate logic and as such it is aimed at students who are already familiar with basics of traditional formal logic. The aim of the module is to provide an overview of alternative logics and to develop a sensitivity that there are many different logics that can provide effective tools for solving problems in specific application domains.

The module first reviews the principles of a traditional logic and then introduces many-valued logics that distinguish more than two truth values, for example true, false, and unknown. Fuzzy logic extends traditional logic by replacing truth values with real numbers in the range 0 to 1 that are expressing how strong the believe into a proposition is. Modal logics introduce modal operators expressing whether a proposition is necessary or possible. Temporal logics deal with propositions that are qualified by time. One can view temporal logics as a form of modal logics where propositions are qualified by time constraints. Interval temporal logic provides a way to reason about time intervals in which propositions are true.

The module will also investigate the application of logic frameworks to specific classes of problems. For example, a special subset of predicate logic, based on so-called Horn clauses, forms the basis of

logic programming languages such as Prolog. Description logics, which are usually decidable logics, are used to model relationships and they have applications in the semantic web, which enables search engines to reason about resources present on the Internet.

This 2.5 CP module supports Academic Excellence by providing essential contextual knowledge that underpins the program's qualification aims, while appropriately limiting academic depth relative to the core technical competencies of the field

Intended Learning Outcomes

No	Competence	ILO
1	Apply	Apply the various principles of logic.
2	Explain	Explain practical relevance of non-standard logic.
3	Describe	Describe how many-valued logic extends basic predicate logic.
4	Apply	Apply basic rules of fuzzy logic to calculate partial truth values.
5	Sketch	Sketch basic rules of temporal logic.
6	Implement	Implement predicates in a logic programming language.
7	Prove	Prove some simple non-standard logic theorems.

Indicative Literature

- Baader, Franz. "The Description Logic Handbook: Theory Implementation and Applications", Cambridge University Press, 2nd edition, May 2010.
- Bergmann, Merry. "An Introduction to Many-Valued and Fuzzy Logic: Semantics, Algebras, and Derivation Systems", Cambridge University Press, April 2008.
- Fisher, Michael. "An Introduction to Practical Formal Methods Using Temporal Logic", Wiley, Juli 2011.
- Sterling, Leon S., Ehud Y. Shapiro, Ehud Y. "The Art of Prolog", 2nd edition, MIT Press, March 1994.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Logic (perspective II)	Written Examination	60 Minutes	100	45%	All

Module Achievement

6.2.3 Causation and Correlation (perspective I)

Module Name	Causation and Correlation (perspective I)
Module Code	2025-CTNS-NSK-03
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Marina Christodoulou

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	4	Mandatory Elective
2025-CS-BSc Computer Science	4	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	4	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	4	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	4	Mandatory Elective
2025-GEM-BA Global Economics and Management	4	Mandatory Elective
2025-IBA-BA International Business Administration	4	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	4	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	4	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	4	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	4	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	4	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	4	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	4	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	4	Mandatory Elective

2025-RIS-BSc Robotics and Intelligent Systems	4	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	4	Mandatory Elective

Student Workload	
Independent Study	27.5
Online Lecture	17.5
Tutorials	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Causation and Correlation	CTNS-03	Lecture (Online)	2.5

Module Description

In many ways, life is a journey. And also, as in other journeys, our success or failure depends not only on our personal traits and character, our physical and mental health, but also on the accuracy of our map. We need to know what the world we are navigating is actually like, the how, why and the what of what makes it work the way it does. The natural sciences provide the most important tool we have developed to learn how the world works and why it works the way it does. The social sciences provide the most advanced tools we have to learn how we and other human beings, similar in most ways, different in many others, act and react and what makes them do what they do. In order for our maps to be useful, they must be accurate and correctly reflect the way the natural and social worlds work and why they work as they do.

The natural sciences and social sciences are blessed with enormous amounts of data. In this way, history and the present are gifts to us. To understand how and why the world works the way it does requires that we are able to offer an explanation of it. The data supports a number of possible explanations of it. How are we to choose among potential explanations? Explanations, if sound, will enable us to make reliable predictions about what the future will be like, and also to identify many possibilities that may unfold in the future. But there are differences not just in the degree of confidence we have in our predictions, but in whether some of them are necessary future states or whether all of them are merely possibilities? Thus, there are three related activities at the core of scientific inquiry: understanding where we are now and how we got here (historical); knowing what to expect going forward (prediction); and exploring how we can change the paths we are on (creativity).

At the heart of these activities are certain fundamental concepts, all of which are related to the scientific quest to uncover immutable and unchanging laws of nature. Laws of nature are thought to reflect a causal nexus between a previous event and a future one. There are also true statements that reflect universal or nearly universal connections between events past and present that are not laws of nature because the relationship they express is that of a correlation between events. A working thermostat accurately allows us to determine or even to predict the temperature in the room in which it is located, but it does not explain why the room has the temperature it has. What then is the core difference between causal relationships and correlations? At the same time, we all recognize that given where we are now there are many possible futures for each of us, and even had our lives gone

just the slightest bit differently than they have, our present state could well have been very different than it is. The relationship between possible pathways between events that have not materialized but could have is expressed through the idea of counterfactual.

Creating accurate roadmaps, forming expectations we can rely on, making the world a more verdant and attractive place requires us to understand the concepts of causation, correlation, counterfactual explanation, prediction, necessity, possibility, law of nature and universal generalization. This course is designed precisely to provide the conceptual tools and intellectual skills to implement those concepts in our future readings and research and ultimately in our experimental investigations, and to employ those tools in various disciplines.

This 2.5 CP module supports Academic Excellence by providing essential contextual knowledge that underpins the program's qualification aims, while appropriately limiting academic depth relative to the core technical competencies of the field

Intended Learning Outcomes

No	Competence	ILO
1	Formulate	Formulate testable hypotheses that are designed to reveal causal connections and those designed to reveal interesting, important and useful correlations.
2	Distinguish	Distinguish scientifically interesting correlations from unimportant ones.
3	Apply	Apply critical thinking skills to evaluate information.
4	Understand	Understand when and why inquiry into unrealized possibility is important and relevant.

Indicative Literature

- Goodman, Nelson. Fact, fiction, and forecast. Harvard University Press, 1983.
- Quine Willard, Van Orman, and Joseph Silbert Ullian. The web of belief. Vol 2. New York: Random house, 1978.
- Thomas S. Kuhn: The Structure of Scientific Revolutions. Nelson, fourth edition, 2012.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs

Causation and Correlation	Written Examination	60 Minutes	100	45%	1-4

Module Achievement

6.2.4 Causation and Correlation (perspective II)

Module Name	Causation and Correlation (perspective II)
Module Code	2025-CTNS-NSK-04
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Eoin Ryan Dr. Irina Chiaburu Prof. Dr. Keivan Mallahi Karai

Study Semester		
Program	**Semester**	**Status**
2025-ISCP-BA Integrated Social and Cognitive Psychology	3	Mandatory Elective
2025-S-ACS-BSc Applied Computer Science	3	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	4	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	4	Mandatory Elective
2025-CS-BSc Computer Science	4	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	4	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	4	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	4	Mandatory Elective
2025-GEM-BA Global Economics and Management	4	Mandatory Elective
2025-IBA-BA International Business Administration	4	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	4	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	4	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	4	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	4	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	4	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	4	Mandatory Elective

2025-MDDA-BSc Management, Decisions and Data Analytics	4	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	4	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	4	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	4	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	4	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory Elective

Student Workload	
Independent Study	45
Online Lecture	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Causation and Correlation (perspective II)	CTNS-04	Lecture (Online)	2.5

Module Description

Causality or causation is a surprisingly difficult concept to understand. David Hume famously noted that causality is a concept that our science and philosophy cannot do without, but it is equally a concept that our science and philosophy cannot describe. Since Hume, the problem of cause has not gone away, and sometimes seems to get even worse (e.g., quantum mechanics confusing previous notions of causality). Yet, ways of doing science that lessen our need to explicitly use causality have become very effective (e.g., huge developments in statistics). Nevertheless, it still seems that the concept of causality is at the core of explaining how the world works, across fields as diverse as physics, medicine, logistics, the law, sociology, and history - and ordinary daily life - through all of which, explanations and predictions in terms of cause and effect remain intuitively central.

Causality remains a thorny problem but, in recent decades, significant progress has occurred, particularly in work by or inspired by Judea Pearl. This work incorporates many 20th century developments, including statistical methods - but with a reemphasis on finding the why, or the cause, behind statistical correlations -, progress in understanding the logic, semantics and metaphysics of conditionals and counterfactuals, developments based on insights from the likes of philosopher Hans Reichenbach or biological statistician Sewall Wright into causal precedence and path analysis, and much more. The result is a new toolkit to identify causes and build causal explanations. Yet even as we get better at identifying causes, this raises new (or old) questions about causality, including metaphysical questions about the nature of causes (and effects, events, objects, etc), but also questions about what we really use causality for (understanding the world as it is or just to glean predictive control of specific outcomes), about how causality is used differently in different fields and

activities (is cause in physics the same as that in history?), and about how other crucial concepts relate to our concept of cause (space and time seem to be related to causality, but so do concepts of legal and moral responsibility).

This course will introduce students to the mathematical formalism derived from Pearl's work, based on directed acyclic graphs and probability theory. Building upon previous work by Reichenbach and Wright, Pearl defines a "a calculus of interventions" of "do-calculus" for talking about interventions and their relation to causation and counterfactuals. This model has been applied in various areas ranging from econometrics to statistics, where acquiring knowledge about causality is of great importance.

At the same time, the course will not forget some of the metaphysical and epistemological issues around cause, so that students can better critically evaluate putative causal explanations in their full context. Abstractly, such issues involve some of the same philosophical questions Hume already asked, but more practically, it is important to see how metaphysical and epistemological debates surrounding the notion of cause affect scientific practice, and equally if not more importantly, how scientific practice pushes the limits of theory. This course will look at various ways in which empirical data can be transformed into explanations and theories, including the variance approach to causality (characteristic of the positivistic quantitative paradigm), and the process theory of causality (associated with qualitative methodology). Examples and case studies will be relevant for students of the social sciences but also students of the natural/physical world as well.

This 2.5 CP module supports Academic Excellence by providing essential contextual knowledge that underpins the program’s qualification aims, while appropriately limiting academic depth relative to the core technical competencies of the field

Recommended Knowledge

Basic probability theory

Intended Learning Outcomes

No	Competence	ILO
1	Have	Have a clear understanding of the history of causal thinking.
2	Form	Form a critical understanding of the key debates and controversies surrounding the idea of causality.
3	Recognize	Recognize and apply probabilistic causal models.
4	Explain	Explain how understanding of causality differs among different disciplines.
5	Demonstrate	Demonstrate how theoretical thinking about causality has shaped scientific practices.

Indicative Literature

- Ilari, Phyllis McKay and Federica Russo. Causality: Philosophical Theory Meets Scientific Practice. Oxford University Press 2014.
- Paul, L. A. and Ned Hall. Causation: A User’s Guide. Oxford University Press 2013.

- Pearl, Judea, Glymour Madelyn and Jewell, Nicolas. Causal Inference in Statistics: A Primer. Wiley 2016.
- Pearl, Judea. Causality: Models, Reasoning and Inference. Cambridge University Press 2009.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Causation and Correlation (perspective II)	Written Examination	60 Minutes	100	45%	1-5

Module Achievement

6.2.5 Models, Matrices and Theories of Complex Systems

Module Name	**Models, Matrices and Theories of Complex Systems**
Module Code	2025-CTNS-NSK-05
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Marc-Thorsten Hütt

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	5	Mandatory Elective
2025-CBT-BSc **Chemistry and Biotechnology**	5	Mandatory Elective
2025-CS-BSc Computer Science	5	Mandatory Elective
2025-ECE-BSc **Electrical and Computer Engineering**	5	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	5	Mandatory Elective
2025-GEM-BA Global Economics and Management	5	Mandatory Elective
2025-IBA-BA International Business Administration	5	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	5	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	5	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	5	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	5	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	5	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	5	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	5	Mandatory Elective

Student Workload	
Independent Study	90
Online Lecture	35
Total Hours	**125**

Module Components	Number	Type	CP
Models, Matrices and Theories of Complex Systems	CTNS-05	Seminar (Online)	5

Module Description

Linear and nonlinear models together with matrix approaches can be useful in diverse disciplines to implement quantitative, computational approaches to exploring complex systems. Some of the most popular data and systems analysis strategies are built upon matrices. Examples include principal component analysis (PCA), the optimization techniques used in Operations Research (OR), the assessment of stable and unstable states in nonlinear dynamical systems, as well as aspects of machine learning.

Here we introduce the toolbox of linear models and matrix-based methods embedded in a wide range of transdisciplinary applications (part 1). We describe its foundation in linear algebra and graph theory(part 2) and the embedding of these systems in nonlinear dynamics (part 3). At the end of the course, we outline applications to graph theory and machine learning (part 4). Along the way we will encountersome of the classical approaches in complex systems: self-organization, deterministic chaos, cellular atomata and fractals. Throughout the course, examples from neuroscience, social sciences, medicine, biology, physics, chemistry, and other fields are used to illustrate these methods.

A strong emphasis of the course is on the sensible usage of linear approaches in a nonlinear world. We will critically reflect the advantages, as well as the disadvantages and limitations of this method. Guiding questions are: How appropriate is a linear approximation of a nonlinear system? What do you really learn from PCA? How reliable are the optimal states obtained via linear programming (LP) techniques?

In the end, students will have a clearer understanding of matrix approaches, as well as linear and nonlinear models in their own discipline, but they will also see the full transdisciplinarity of this topic. They will make better decisions in their choice of data analysis methods and become mindful of the challenges when going from linear to nonlinear thinking.

Intended Learning Outcomes

No	Competence	ILO
1	Apply	Apply the concept of linear modeling in their own discipline.
2	Distinguish	Distinguish between linear and nonlinear interpretation strategies and understand the range of applicability of linear models.
3	Make	Make use of data analysis / data interpretation strategies from other disciplines, which are derived from linear algebra.
4	Know	Be aware of the ties that linear models have to machine learning and network theory,

5	Note	Note that these four ILOs can be loosely associated with the four parts of the course indicated above.

Indicative Literature

- Part 1: material from Linear Algebra for Everyone, Gilbert Strang, Wellesley-Cambridge Press, 2020.
- Part 2: material from Introduction to Linear Algebra (5th Edition), Gilbert Strang, Cambridge University Press, 2021.
- Part 3: Mainzer, Klaus. "Introduction: from linear to nonlinear thinking." Thinking in Complexity: The Computational Dynamics of Matter, Mind and Mankind (2007): 1-16.; material from Mathematics of Big Data: Spreadsheets, Databases, Matrices, and Graphs, Jeremy Kepner, Hayden Jananthan, The MIT Press, 2018.; material from Introduction to Linear Algebra (5th Edition), Gilbert Strang, Cambridge University Press, 2021.
- Part 4: material from Linear Algebra and Learning from Data, Gilbert Strang, Wellesley-Cambridge Press, 2019.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Models, Matrices and Theories of Complex Systems	Written Examination	120 Minutes	100	45%	1-4

Module Achievement

6.2.6 Complex Problem Solving

Module Name	Complex Problem Solving
Module Code	2025-CTNS-NSK-06
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Marco Verweij

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	5	Mandatory Elective
2025-CBT-BSc **Chemistry and Biotechnology**	5	Mandatory Elective
2025-CS-BSc Computer Science	5	Mandatory Elective
2025-ECE-BSc **Electrical and Computer Engineering**	5	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	5	Mandatory Elective
2025-GEM-BA Global Economics and Management	5	Mandatory Elective
2025-IBA-BA International Business Administration	5	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	5	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	5	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	5	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	5	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	5	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	5	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	5	Mandatory Elective

Student Workload	
Independent Study	72.5
Online Lecture	35
Tutorials	17.5
Total Hours	**125**

Module Components	Number	Type	CP
Complex Problem Solving	CTNS-06	Lecture (Online)	5

Module Description

Complex problems are, by definition, non-linear and/or emergent. Some fifty years ago, scholars such as Herbert Simon began to argue that societies around the world had developed an impressive array of tools with which to solve simple and even complicated problems, but still needed to develop methods with which to address the rapidly increasing number of complex issues. Since then, a variety of such methods has emerged. These include 'serious games' developed in computer science, 'multisector systems analysis' applied in civil and environmental engineering, 'robust decision-making' proposed by the RAND Corporation, 'design thinking' developed in engineering and business studies, 'structured problem-solving' used by McKinsey & Co., 'real-time technology assessment' advocated in science and technology studies, and 'deliberative decision-making' emanating from political science.

In this course, students first learn to distinguish between simple, complicated and complex problems. They also become familiar with the ways in which a particular issue can sometimes shift from one category into another. In addition, the participants learn to apply several tools for resolving complex problems. Finally, the students are introduced to the various ways in which natural and social scientists can help stakeholders resolve complex problems. Throughout the course examples and applications will be used. When possible, guest lectures will be offered by experts on a particular tool for tackling complex issues. For the written, take-home exam, students will have to select a specific complex problem, analyse it and come up with a recommendation - in addition to answering several questions about the material learned.

Recommended Knowledge

- The modules Logic and Causation & Correlation are highly recommended.

Being able to read primary academic literature

- Willingness to engage in teamwork

- Camillus, J. (2008). Strategy as a wicked problem. Harvard Business Review 86: 99-106;

- Rogers, P. J. (2008). Using programme theory to evaluate complicated and complex aspects of interventions. Evaluation, 14, 29–48.

Intended Learning Outcomes

No	Competence	ILO
1	Identify	Identify a complex problem.

2	Develop	Develop an acceptable recommendation for resolving complex problems.
3	Understand	Understand the roles that natural and social scientists can play in helping stakeholders resolve complex problems.

Indicative Literature

- Camillus, J. (2008). Strategy as a wicked problem. Harvard Business Review 86: 99-106; Rogers, P. J. (2008). Using programme theory to evaluate complicated and complex aspects of interventions. Evaluation, 14, 29–48.
- Chia, A. (2019). Distilling the essence of the McKinsey way: The problem-solving cycle. Management Teaching Review 4(4): 350-377.
- Den Haan, J., van der Voort, M.C., Baart, F., Berends, K.D., van den Berg, M.C., Straatsma, M.W., Geenen, A.J.P., & Hulscher, S.J.M.H. (2020). The virtual river game: Gaming using models to collaboratively explore river management complexity, Environmental Modelling & Software 134, 104855.
- Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., & Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. AMBIO: A Journal of the Human Environment 31(5): 437-440.
- Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. American Economic Review 100(3): 641-72.
- Pielke, R. Jr. (2007). The honest broker: Making sense of science in policy and politics. Cambridge: Cambridge University Press.
- Project Management Institute (2021). A guide to the project management body of knowledge (PMBOK® guide).
- Schon, D. A., & Rein, M. (1994). Frame reflection: Toward the resolution of intractable policy controversies. New York: Basic Books.
- Simon, H. A. (1973). The structure of ill structured problems. Artificial Intelligence 4(3-4): 181-201.
- Verweij, M. & Thompson, M. (Eds.) (2006). Clumsy solutions for a complex world. London: Palgrave Macmillan.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Complex Problem Solving	Written Examination	120 Minutes	100	45%	1-3

Module Achievement

The module achievement is designed to encourage students to regularly engage with the online course materials throughout the semester, thereby providing them with a sufficient grounding in the concepts and applications of complex problem-solving to take the exam. The module achievement consists of online quizzes tied to the course content. In order to fulfill the module achievement — and to be eligible to sit for the final exam — students are required to participate in at least 80% of the available online quizzes. The module achievement is assessed on a pass/non-pass basis and does not affect the overall module grade. Given the flexible, online nature of the quizzes, students are able to complete them at their own convenience within the set timeframes. Students who do not meet the 80% participation threshold before their first exam attempt will have the opportunity to fulfill the module achievement prior to their second exam attempt.

6.2.7 Argumentation, Data Visualization and Communication (perspective I)

Module Name	Argumentation, Data Visualization and Communication (perspective I)
Module Code	2025-CTNS-NSK-07
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Arvid Kappas

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	5	Mandatory Elective
2025-CS-BSc Computer Science	5	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	5	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	5	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	5	Mandatory Elective
2025-GEM-BA Global Economics and Management	5	Mandatory Elective
2025-IBA-BA International Business Administration	5	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	5	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	5	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	5	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	5	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	5	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	5	Mandatory Elective

2025-S-ACS-BSc Applied Computer Science	5	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	5	Mandatory Elective

Student Workload	
Independent Study	72.5
Online Lecture	35
Tutorials	**17.5**
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Argumentation, Data Visualization and Communication (perspective I)	CTNS-07	Lecture (Online)	5

Module Description

One must be careful not to confuse argumentation with being argumentative. The latter is an unattractive personal attribute, whereas the former is a requirement of publicly holding a belief, asserting the truth of a proposition, the plausibility of a hypothesis, or a judgment of the value of a person or an asset. It is an essential component of public discourse. Public discourse is governed by norms and one of those norms is that those who assert the truth of a proposition or the validity of an argument or the responsibility of another for wrongdoing open themselves up to good faith requests to defend their claims. In its most general meaning, argumentation is the requirement that one offer evidence in support of the claims they make, as well as in defense of the judgments and assessments they reach. There are different modalities of argumentation associated with different contexts and disciplines. Legal arguments have a structure of their own as do assessments of medical conditions and moral character. In each case, there are differences in the kind of evidence that is thought relevant and, more importantly, in the standards of assessment for whether a case has been successfully made. Different modalities of argumentation require can call for different modes of reasoning. We not only offer reasons in defense of or in support of beliefs we have, judgments we make and hypotheses we offer, but we reason from evidence we collect to conclusions that are warranted by them.

This course is divided into three sections. Section one develops argumentation skills, including how to construct and evaluate claims, how to reason from evidence to conclusions, and how to recognize the cognitive biases and fallacies that can cause arguments to fail. Section two focuses on data visualization as a tool for supporting arguments. A well-designed graph can clarify complex evidence and make an argument accessible, while a poorly designed one can distort the truth. Section three addresses communication. Even a well-designed and supported argument will not persuade its audience if it is not communicated well. You will explore models of communication, the importance of rhetorics, and the ethics of attempting to change the mind of others, including the new and exciting challenges posed by generative AI.

The thread that runs through these sections is a consistent concern with how to support what we claim effectively. Some reasoning is linear: from A we infer B, and from A and B, we infer C,

building stepwise towards a conclusion. But not all reasoning takes this form. Sometimes we argue for a claim by showing that it slots neatly, or fits coherently, with other claims for which we have independent support, or by establishing that those individual pieces of evidence mutually reinforce one another. A key goal of this course is to introduce you to these different structures of justification so that you are aware of both the norms of your discipline and to what makes knowledge trustworthy in the first place. There are three fundamental ideas that we want to extract from this segment of the course. These are (1) that argumentation is itself a requirement of being a researcher who claims to have made findings of one sort or another; (2) that there are different forms of appropriate argumentation for different domains and circumstances; and (3) that there are different forms of reasoning on behalf of various claims or from various bits of evidence to conclusions: whether those conclusions are value judgments, political beliefs, or scientific conclusions. Our goal is to familiarize you with all three of these deep ideas and to help you gain facility with each.

Recommended Knowledge

The modules Logic and Causation & Correlation are highly recommended.

Intended Learning Outcomes

No	Competence	ILO
1	Distinguish	Distinguish among different modalities of argument, e.g. legal arguments, vs. scientific ones.
2	Construct	Construct arguments using tools of data visualization.
3	Communicate	Communicate conclusions and arguments concisely, clearly and convincingly.

Indicative Literature

- Cairo, A (2012). The Functional Art: An introduction to information graphics and visualization. New Ridders.
- Knaflic, C.N. (2015). Storytelling with data: A data visualization guide for business professionals. John Wiley & Sons.
- Tufte, E.R. (1985). The visual display of quantitative information. The Journal for Healthcare Quality (JHQ), 7(3), 15.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Argumentation, Data Visualization and Communication (perspective I)	Written Examination	120 Minutes	100	45%	1-3

Module Achievement

None

6.2.8 Argumentation, Data Visualization and Communication (perspective II)

Module Name	Argumentation, Data Visualization and Communication (perspective II)
Module Code	2025-CTNS-NSK-08
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Prof. Dr. Arvid Kappas

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	6	Mandatory Elective
2025-CS-BSc Computer Science	6	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	6	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	6	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	6	Mandatory Elective
2025-GEM-BA Global Economics and Management	6	Mandatory Elective
2025-IBA-BA International Business Administration	6	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	6	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	6	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	6	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	6	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	6	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	6	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	6	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	6	Mandatory Elective

2025-S-ACS-BSc Applied Computer Science	6	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	6	Mandatory Elective

Student Workload	
Independent Study	80
Online Lecture	35
Tutorial	10
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Argumentation, Data Visualization and Communication (perspective II)	CTNS-08	Lecture (Online)	5

Module Description

Humans are a social species, and interaction is crucial throughout the entire life span. While much of human communication involves language, there is a complex multichannel system of nonverbal communication that enriches linguistic content, provides context, and is also involved in structuring dynamic interaction. Interactants achieve goals by encoding information that is interpreted in the light of current context in transactions with others. This complexity implies also that there are frequent misunderstandings as a sender's intention is not fulfilled. Students in this course will learn to understand the structure of communication processes in a variety of formal and informal contexts. They will learn what constitutes challenges to achieving successful communication and to how to communicate effectively, taking the context and specific requirements for a target audience into consideration. These aspects will be discussed also in the scientific context, as well as business, and special cases, such as legal context - particularly with view to argumentation theory.

Communication is a truly transdisciplinary concept that involves knowledge from diverse fields such as biology, psychology, neuroscience, linguistics, sociology, philosophy, communication and information science. Students will learn what these different disciplines contribute to an understanding of communication and how theories from these fields can be applied in the real world. In the context of scientific communication, there will also be a focus on visual communication of data in different disciplines. Good practice examples will be contrasted with typical errors to facilitate successful communication also with view to the Bachelor's thesis.

Recommended Knowledge

- The modules Logic and Causation & Correlation are highly recommended.

- Ability and openness to engage in interactions

- Media literacy, critical thinking and a proficient handling of data sources

- Own research in academic literature

Intended Learning Outcomes

No	Competence	ILO
1	Analyze	Analyze communication processes in formal and informal contexts.
2	Identify	Identify challenges and failures in communication.
3	Design	Design communications to achieve specified goals to specific target groups.
4	Understand	Understand the principles of argumentation theory.
5	Use	Use data visualization in scientific communications.

Indicative Literature

- Douglas Walton: Argumentation Theory – A Very Short Introduction. In: Simari, G., Rahwan, I. (eds) Argumentation in Artificial Intelligence. Springer, Boston, MA, 2009.
- Joseph A. DeVito: The Interpersonal Communication Book (Global edition, 16th edition), 2022.
- Steven L. Franconeri, Lace M. Padilla, Priti Shah, Jeffrey M. Zacks, and Jessica Hullman: The Science of Visual Data Communication: What Works Psychological Science in the Public Interest, 22(3), 110–161, 2022.

Entry Requirements

Prerequisites	
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Argumentation, Data Visualization and Communication (perspective II)	Presentation	7-11 mins	100	45%	1-5

Module Achievement

None

6.2.9 Agency, Leadership, and Accountability

Module Name	Agency, Leadership, and Accountability
Module Code	2025-CTNS-NSK-09
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Marina Christodoulou

Study Semester		
Program	**Semester**	**Status**
2025-S-ACS-BSc Applied Computer Science	5	Mandatory
2025-BCCB-BSc Biochemistry and Cell Biology	6	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	6	Mandatory Elective
2025-CS-BSc Computer Science	6	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	6	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	6	Mandatory Elective
2025-F-ACS-BSc Applied Computer Science	6	Mandatory Elective
2025-GEM-BA Global Economics and Management	6	Mandatory Elective
2025-IBA-BA International Business Administration	6	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	6	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	6	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	6	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	6	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	6	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	6	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	6	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	6	Mandatory Elective

2025-SDT-BSc Software, Data and Technology	6	Mandatory Elective

Student Workload	
Independent Study	72.5
Online Lecture	35
Tutorials	17.5
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Agency, Leadership, and Accountability	CTNS-09	Lecture (Online)	5

Module Description

Each of us is judged by the actions we undertake and held to account for the consequences of them. Sometimes we may be lucky and our bad acts don't have harmful effects on others. Other times we may be unlucky and reasonable decisions can lead to unexpected or unforeseen adverse consequences for others. We are therefore held accountable both for choices and for outcomes. In either case, accountability expresses the judgment that we bear responsibility for what we do and what happens as a result. But our responsibility and our accountability in these cases is closely connected to the idea that we have agency.

Agency presumes that we are the source of the choices we make and the actions that result from those choices. For some, this may entail the idea that we have free will. But there is scientific world view that holds that all actions are determined by the causes that explain them, which is the idea that if we knew the causes of your decisions in advance, we would know the decision you would make even before you made it. If that is so, how can your choice be free? And if it is not free, how can you be responsible for it? And if you cannot be responsible, how can we justifiably hold you to account for it?

These questions express the centuries old questions about the relationship between free will and a determinist world view: for some, the conflict between a scientific world view and a moral world view.

But we do not always act as individuals. In society we organize ourselves into groups: e.g. tightly organized social groups, loosely organized market economies, political societies, companies, and more. These groups have structure. Some individuals are given the responsibility of leading the group and of exercising authority. But one can exercise authority over others in a group merely by giving orders and threatening punishment for non-compliance.

Exercising authority is not the same thing as being a leader? For one can lead by example or by encouraging others to exercise personal judgment and authority. What then is the essence of leadership?

The module has several educational goals. The first is for students to understand the difference between actions that we undertake for which we can reasonably held accountable and things that we do but which we are not responsible for. For example, a twitch is an example of the latter, but so too may be a car accident we cause as a result of a heart attack we had no way of anticipating or

controlling. This suggests the importance of control to responsibility. At the heart of personal agency is the idea of control. The second goal is for students to understand what having control means. Some think that the scientific view is that the world is deterministic, and if it is then we cannot have any personal control over what happens, including what we do. Others think that the quantum scientific view entails a degree of indeterminacy and that free will and control are possible, but only in the sense of being unpredictable or random. But then random outcomes are not ones we control either. So, we will devote most attention to trying to understand the relationships between control, causation and predictability.

But we do not only exercise agency in isolation. Sometimes we act as part of groups and organizations. The law often recognizes ways in which groups and organizations can have rights, but is there a way in which we can understand how groups have responsibility for outcomes that they should be accountable for. We need to figure out then whether there is a notion of group agency that does not simply boil down to the sum of individual actions. We will explore the ways in which individual actions lead to collective agency.

Finally we will explore the ways in which occupying a leadership role can make one accountable for the actions of others over which one has authority.

Intended Learning Outcomes

No	Competence	ILO
1	Understand	Understand and reflect how the social and moral world views that rely on agency and responsibility are compatible, if they are, with current scientific world views.
2	Understand	Understand how science is an economic sector, populated by large powerful organizations that set norms, fund research agendas.
3	Identify	Identify the difference between being a leader of others or of a group - whether a research group or a lab or a company - and being in charge of the group.
4	Learn	Learn to be a leader of others and groups. Understand that when one graduates one will enter not just a field of work but a heavily structured set of institutions and that one's agency and responsibility for what happens, what work gets done, its quality and value, will be affected accordingly.

Indicative Literature

- Feinberg, Joel. "Doing & deserving; essays in the theory of responsibility." (1970).
- Hull, David L. "Science as a Process." Science as a Process. University of Chicago Press, 2010.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Agency, Leadership, and Accountability	Written Examination	120 Minutes	100	45%	1-4

Module Achievement

6.2.1 Community Impact Project

Module Name	Community Impact Project
Module Code	2025-CTNS-CIP-10
Module ECTS	5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	CIP Faculty Coordinator

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	5	Mandatory Elective
2025-CBT-BSc **Chemistry and Biotechnology**	5	Mandatory Elective
2025-ECE-BSc **Electrical and Computer Engineering**	5	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	5	Mandatory Elective
2025-IBA-BA International Business Administration	5	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	5	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	5	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	5	Mandatory Elective
2025-CS-BSc Computer Science	5	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	5	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	5	Mandatory Elective
2025-GEM-BA Global Economics and Management	5	Mandatory Elective
2025-IBA-BA International Business Administration	5	Mandatory Elective
2025-IRPH-BA International Relations: Politics and History	5	Mandatory Elective

2025-ISCP-BA Integrated Social and Cognitive Psychology	5	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	5	Mandatory Elective
2025-MDDA-BSc Management, Decisions and Data Analytics	5	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	5	Mandatory Elective

Student Workload	
Introductory, Accompanying, and Final Events	10
Self-Organized Teamwork	115
Total Hours	**125**

Module Components	**Number**	**Type**	**CP**
Community Impact Project	CTNS-10	Project	5

odule Description

CIPs are self-organized, major-related, and problem-centered applications of students' acquired knowledge and skills. These activities will ideally be connected to their majors so that they will challenge the students' sense of practical relevance and social responsibility within the field of their studies. Projects will tackle real issues in their direct and/or broader social environment. These projects ideally connect the campus community to other communities, companies, or organizations in a mutually beneficial way.

Students are encouraged to create their own projects and find partners (e.g., companies, schools, NGOs), but will get help from the CIP faculty coordinator team and faculty mentors to do so. They can join and collaborate in interdisciplinary groups that attack a given issue from different disciplinary perspectives.

Student activities are self-organized but can draw on the support and guidance of both faculty and the CIP faculty coordinator team.

Student may begin their project in the 4th semester but must complete it by the end of the 5th semester; the module counts towards the workload of the 5th semester.

Usability and Relationship to other Modules

Students who have accomplished their CIP (6th semester) are encouraged to support their fellow students during the development phase of the next year's projects (4th semester).

Recommended Knowledge

- Basic knowledge of the main concepts and methodological instruments of the respective disciplines.

- Develop or join a community impact project before the 5th or 6th semester based on the introductory events during the 4th semester by using the database of projects, communicating with fellow students and faculty, and finding potential companies, organizations, or communities to target.

Intended Learning Outcomes

No	Competence	ILO
1	Understand	Understand the real-life issues of communities, organizations, and industries and relate them to concepts in their own discipline.
2	Enhance	Enhance problem-solving skills and develop critical faculty, create solutions to problems, and communicate these solutions appropriately to their audience.
3	Apply	Apply media and communication skills in diverse and non-peer social contexts.
4	Develop	Develop an awareness of the societal relevance of their own scientific actions and a sense of social responsibility for their social surroundings.
5	Reflect	Reflect on their own behavior critically in relation to social expectations and consequences.
6	Work	Work in a team and deal with diversity, develop cooperation and conflict skills, and strengthen their empathy and tolerance for ambiguity.
		The Community Impact Project is designed to convey the required personal and social competencies for enabling students to finish their studies at Constructor University as socially conscious and responsible graduates (part of the Constructor University's mission) and to convey social and personal abilities to the students, including a practical awareness of the societal context and relevance of their academic discipline.

Indicative Literature

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Community Impact Project	Project Assessment		100	Pass/Fail	All

Module Achievement

6.3 Language and Humanities Modules

6.3.1 Languages

The descriptions of the language modules are provided in a separate document, the "Language Module Handbook" that can be accessed from the Constructor University's Language & Community Center internet sites https://constructor.university/student-life/language-community-center.

6.3.2 Introduction to the Philosophy of Science

Module Name	Introduction to the Philosophy of Science
Module Code	2025-CTHU-HUM-002
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Eoin Ryan

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	1	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	1	Mandatory Elective
2025-CS-BSc Computer Science	1	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	1	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	1	Mandatory Elective
2025-GEM-BA Global Economics and Management	1	Mandatory Elective
2025-IBA-BA International Business Administration	1	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	1	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	1	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	1	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	1	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	1	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	1	Mandatory Elective

2025-RIS-BSc Robotics and Intelligent Systems	1	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	1	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	2	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	2	Mandatory Elective
2025-CS-BSc Computer Science	2	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	2	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	2	Mandatory Elective
2025-IBA-BA International Business Administration	2	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	2	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	2	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	2	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	2	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	2	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	2	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	2	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	2	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	2	Mandatory Elective

Student Workload	
Independent Study	45
Online Lecture	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Introduction to the Philosophy of Science	CTHU-002	Lecture (Online)	2.5

Module Description

This humanities module will introduce students to some of the central ideas in philosophy of science. Topics will include distinguishing science from pseudo-science, types of inference and the problem of induction, the pros and cons of realism and anti-realism, the role of explanation, the nature of scientific change, the difference between natural and social sciences, scientism and the values of science, as well as some examples from philosophy of the special sciences (e.g., physics, biology).

The course aims to give students an understanding of how science produces knowledge, and some of the various contexts and issues which mean this process is never entirely transparent, neutral, or unproblematic. Students will gain a critical understanding of science as a human practice and technology; this will enable them both to better understand the importance and success of science, but also how to properly critique science when appropriate.

This 2.5 CP module is part of a portfolio of several 2.5 CP modules designed to allow students to have a wider choice of electives. To compensate for the smaller size of this module, the assessment is of smaller scope.

Intended Learning Outcomes

No	Competence	ILO
1	Understand	Understand key ideas from the philosophy of science.
2	Discuss	Discuss different types of inference and rational processes.
3	Describe	Describe differences between how the natural sciences, social sciences and humanities discover knowledge.
4	Identify	Identify ways in which science can be more and less value-laden.
5	Illustrate	Illustrate some important conceptual leaps in the history of science.

Indicative Literature

- James Ladyman, Understanding Philosophy of Science (2002).
- Paul Song, Philosophy of Science: Perspectives from Scientists (2022).
- Peter Godfrey-Smith Theory and Reality (2021)

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Introduction to the Philosophy of Science	Written Examination	60 Minutes	100	45%	1-5

Module Achievement

6.3.3 Introduction to Visual Culture

Module Name	Introduction to Visual Culture
Module Code	2025-CTHU-HUM-003
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Irina Chiaburu

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc Biochemistry and Cell Biology	1	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	1	Mandatory Elective
2025-CS-BSc Computer Science	1	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	1	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	1	Mandatory Elective
2025-IBA-BA International Business Administration	1	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	1	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	1	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	1	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	1	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	1	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	1	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	2	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	2	Mandatory Elective
2025-CS-BSc Computer Science	2	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	2	Mandatory Elective
2025-ESSMER-BSc	2	Mandatory Elective

Earth Sciences and Sustainable Management of Environmental Resources		
2025-GEM-BA Global Economics and Management	2	Mandatory Elective
2025-IBA-BA International Business Administration	2	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	2	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	2	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	2	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	2	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	2	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	2	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	2	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	2	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	2	Mandatory Elective

Student Workload	
Independent Study	45
Online Lecture	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Introduction to Visual Culture	CTHU-003	Lecture (Online)	2.5

Module Description

Of the five senses, the sense of sight has for a long time occupied the central position in human cultures. As John Berger has suggested this could be because we can see and recognize the world around us before we learn how to speak. Images have been with us since the earliest days of the human history. In fact, the earliest records of human history are images found on cave walls across the world. We use images to capture abstract ideas, to catalogue and organize the world, to represent the world, to capture specific moments, to trace time and change, to tell stories, to express feelings, to better understand, to provide evidence and more. At the same time, images exert their power on us, seducing us into believing in their 'innocence', that is into forgetting that as representations they are also interpretations, i.e., a particular version of the world.

The purpose of this course is to explore multiple ways in which images and the visual in general mediate and structure human experiences and practices from more specialized discourses, e.g., scientific discourses, to more informal and personal day-to-day practices, such as self-fashioning in cyberspace. We will look at how social and historical contexts affect how we see, as well as what is visible and what is not. We will explore the centrality of the visual to the intellectual activity, from early genres of scientific drawing to visualizations of big data. We will examine whether one can speak of visual culture of protest, look at the relationship between looking and subjectivity and, most importantly, ponder the relationship between the visual and the real.

This 2.5 CP module is part of a portfolio of several 2.5 CP modules designed to allow students to have a wider choice of electives. To compensate for the smaller size of this module, the assessment is of smaller scope.

Intended Learning Outcomes

No	Competence	ILO
1	Understand	Understand a range of key concepts pertaining to visual culture, art theory and cultural analysis.
2	Understand	Understand the role visuality plays in development and maintenance of political, social, and intellectual discourses.
3	Think	Think critically about images and their contexts.
4	Reflect	Reflect critically on the connection between seeing and knowing.

Indicative Literature

- Berger, J., Blomberg, S., Fox, C., Dibb, M., & Hollis, R. (1973). Ways of seeing.
- Foucault, M. (2002). The order of things: an archaeology of the human sciences (Ser. Routledge classics). Routledge.
- Hunt, L. (2004). Politics, culture, and class in the French revolution: twentieth anniversary edition, with a new preface (Ser. Studies on the history of society and culture, 1). University of California Press.
- Miller, V. (2020). Understanding digital culture (Second). SAGE.
- Thomas, N. (1994). Colonialism's culture: anthropology, travel and government. Polity Press.

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs

Introduction to Visual Culture	Written Examination	60 Minutes	100	45%	1-4

Module Achievement

6.3.4 Introduction to Philosophical Ethics

Module Name	Introduction to Philosophical Ethics
Module Code	2025-CTHU-HUM-001
Module ECTS	2.5
Program Owner	2025-CT (CONSTRUCTOR Track Area)
Module Coordinator	Dr. Eoin Ryan

Study Semester		
Program	**Semester**	**Status**
2025-BCCB-BSc **Biochemistry and Cell Biology**	1	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	1	Mandatory Elective
2025-CS-BSc Computer Science	1	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	1	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	1	Mandatory Elective
2025-IBA-BA International Business Administration	1	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	1	Mandatory Elective
2025-IEM-BSc Industrial Engineering & Management	1	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	1	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	1	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	1	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	1	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	1	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	1	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	1	Mandatory Elective
2025-BCCB-BSc Biochemistry and Cell Biology	2	Mandatory Elective
2025-CBT-BSc Chemistry and Biotechnology	2	Mandatory Elective

2025-CS-BSc Computer Science	2	Mandatory Elective
2025-ECE-BSc Electrical and Computer Engineering	2	Mandatory Elective
2025-ESSMER-BSc Earth Sciences and Sustainable Management of Environmental Resources	2	Mandatory Elective
2025-GEM-BA Global Economics and Management	2	Mandatory Elective
2025-IBA-BA International Business Administration	2	Mandatory Elective
2025-IBA-Online-BA International Business Administration (Online)	2	Mandatory Elective
2025-IEM-Online-BSc Industrial Engineering & Management (Online)	2	Mandatory Elective
2025-ISCP-BA Integrated Social and Cognitive Psychology	2	Mandatory Elective
2025-MCCB-BSc Medicinal Chemistry and Chemical Biology	2	Mandatory Elective
2025-MMDA-BSc Mathematics, Modeling, and Data Analytics	2	Mandatory Elective
2025-PHDS-BSc Physics and Data Science	2	Mandatory Elective
2025-RIS-BSc Robotics and Intelligent Systems	2	Mandatory Elective
2025-SDT-BSc Software, Data and Technology	2	Mandatory Elective

Student Workload	
Independent Study	45
Online Lecture	17.5
Total Hours	**62.5**

Module Components	**Number**	**Type**	**CP**
Introduction to Philosophical Ethics	CTHU-001	Lecture (Online)	2.5

Module Description

The nature of morality - how to lead a life that is good for yourself, and how to be good towards others - has been a central debate in philosophy since the time of Socrates, and it is a topic that continues to be vigorously discussed. This course will introduce students to some of the key aspects of philosophical ethics, including leading normative theories of ethics (e.g. consequentialism or utilitarianism, deontology, virtue ethics, natural law ethics, egoism) as well as some important questions from metaethics (are useful and generalizable ethical claims even possible; what do ethical speech and

ethical judgements actually do or explain) and moral psychology (how do abstract ethical principles do when realized by human psychologies). The course will describe ideas that are key factors in ethics (free will, happiness, responsibility, good, evil, religion, rights) and indicate various routes to progress in understanding ethics, as well as some of their difficulties.

This 2.5 CP module is part of a portfolio of several 2.5 CP modules designed to allow students to have a wider choice of electives. To compensate for the smaller size of this module, the assessment is of smaller scope.

Intended Learning Outcomes

No	Competence	ILO
1	Describe	Describe normative ethical theories such as consequentialism, deontology and virtue ethics.
2	Discuss	Discuss some metaethical concerns.
3	Analyze	Analyze ethical language.
4	Highlight	Highlight complexities and contradictions in typical ethical commitments.
5	Indicate	Indicate common parameters for ethical discussions at individual and social levels.
6	Analyze	Analyze notions such as objectivity, subjectivity, universality, pluralism, value.

Indicative Literature

- Mark van Roojen Metaethicas: A Contemporary Introduction (2015).
- Russ Shafer-Landay A Concise Introduction to Ethics (2019).
- Simon Blackburn Being Good (2009).

Entry Requirements

Prerequisites	None
Co-requisites	None
Additional Remarks	None

Assessment and Completion

Module Component	Examination Type	Duration or Length	Weight (%)	Minimum for Pass	ILOs
Introduction to Philosophical Ethics	Written Examination	60 Minutes	100	45%	1-6

Module Achievement

7 Appendix

7.1 Intended Learning Outcomes Assessment Matrix

Biochemistry and Cell Biology BSc					General Biochemistry	General Cell Biology	General and inorganic Chemistry	General Organic Chemistry	Microbiology	Microbilogy Lab	Infection and Immunity	Advanced Biochemistry I	Advanced Biochemistry II	Advanced Biochemistry Lab	Advanced Cell Biology I	Advanced Cell Biology Lab	Advanced Cell Biology II	Current Topics in the Molecular Life Sciences	Experimental Strategy Design	Biomedicine	Internship / Startup and Career Skills	Bachelor Thesis and Seminar BCCB	CT Methods	CT German Language and Humanities Modules	CT New Skills
Semester					1	2	1	2	3	3	4	3	4	4	3	4	4	5	5	6	4-5	6	1-4	1-2	3-6
Mandatory/mandatory elective					m	m	m	m	m	me	me	m	m	m	m	m	m	me	me	me	m	m	m/me	m	m
Credits					7.5	7.5	7.5	7.5	5	2.5	7.5	5	5	5	5	5	5	5	5	5	15	15	20	5	20
	Competencies*																								
Program Learning Outcomes	**A**	**E**	**P**	**S**																					
Apply basic concepts from the natural sciences (general chemistry, organic chemistry, physics) and mathematics, including statistics	x	x					x	x	x														x		
Explain the basic concepts within the fields of biochemistry and cell biology;	x	x			x	x			x	x															
Recognize general biochemical reactivity patterns and metabolic pathways;	x	x			x		x	x	x	x		x											x		
Explain how the structure and biochemical properties of biomolecules define their cellular function;	x	x			x	x			x		x	x	x	x	x	x			x				x		
Explain general processes governing cellular and early developmental biology in health and diseased conditions;	x	x		x		x			x	x	x	x	x		x	x	x			x			x		
Describe the molecular principles underlying gene expression and regulation;	x	x		x		x			x	x	x		x	x		x	x		x						
Apply state-of-the-art techniques to experimentally analyze biomolecules and cells;	x	x			x	x		x	x	x						x						x	x		
Collect, analyze and evaluate relevant literature within the fields of biochemistry, molecular biology and cell biology;	x	x							x	x	x		x	x	x	x	x	x	x	x		x	x		
Use their acquired theoretical knowledge and practical skills to design and implement experimental approaches to address scientific questions in the modern Life Sciences;	x	x	x	x					x	x				x		x			x	x		x			
Generate, analyze and interpret data according to good scientific practice and ethical standards;	x	x	x	x	x	x	x	x	x		x			x		x			x			x	x		x
Present their own results, and those of others, concisely and professionally both, in writing and in front of an audience;	x	x	x	x	x	x	x	x	x	x				x		x		x	x	x		x			x
Develop and advance solutions to problems in the Life Sciences and defend these in discussions with specialists and non-specialists;	x	x	x	x						x	x		x		x		x	x	x	x		x	x		
Explore related subjects such as biotechnology, biophysics, bioinformatics, organic chemistry, drug design, marine science, food analytics, and others;	x	x							x	x	x	x	x		x	x	x	x	x	x		x	x		
Acquire knowledge rapidly, gather, evaluate and interpret relevant information and evaluate new concepts critically to derive scientifically founded judgements;	x	x	x	x							x	x	x	x	x	x	x	x	x	x	x	x			(x)
Evaluate situations and take decisions based on ethical considerations, and adhere to and defend ethical, scientific and professional standards;			x	x									x		x	x	x	x		x	x	x	x	(x)	x
Negotiate and mediate between different points of view and to manage conflicts;			x	x									x		x		x	x		x	x	x	x		x
Analyze global issues of economic, political, scientific, social or technological nature;		x	x	x					x		x		x		x		x	x	x				x	(x)	x
Take on responsibility in diverse and interdisciplinary teams, exhibiting tolerance and intercultural awareness;		x	x	x	x	x	x	x	x	x				x		x		x	x	x	x	x		x	x
Take on responsibility for their own and their team's learning, personal and professional development and role in society, evaluating critical feedback and using self-analysis;		x	x	x	x	x	x	x	x					x		x		x	x	x	x	x			x
Take on responsibility for their professional community and society.		x	x	x					x		x		x		x	x	x	x		x	x	x	x	x	x
Assessment Type																									
Written examination					x	x	x	x	x		x	x	x		x		x						x	x	x
Term paper																									
Essay																								x	
Project report																					x				
Poster presentation																				x					
Laboratory report					x	x	x	x		x				x		x									
Program Code																									
Oral examination																								x	
Presentation																		x				x			x
Practical Assessments																									
Project assessments																									x
Portfolio Assessments																			x						
Bachelor Thesis																						x			
Module achievements					x	x																	x	x	x

*Competencies: A-scientific/academic proficiency; E-competence for qualified employment; P-development of personality; S-competence for engagement in society

Figure 4: Intended Learning Outcomes Assessment Matrix