

Bachelor of Science Molekulare Biotechnologie

Basic Modules (Year 1 and 2)

Basics of General and Inorganic Chemistry

11 CPs

Introduction to General and Inorganic Chemistry (lecture) 56 contact hours

- atoms
- periodic table of the elements
- chemical bonds
- chemical equations
- gases
- kinetics, thermodynamics and chemical equilibrium
- fluids, solutions
- quantitative equilibrium and redox equilibrium
- electrochemistry

-Inorganic Chemistry (practical course) 56 contact hours

- titration
- complexometry
- qualitative inorganic analysis

Basics of Organic Chemistry

12 CPs

Introduction to Organic Chemistry (lecture) 45 contact hours

- basic organic compounds (alkanes, alkenes...)
- reaction mechanisms: redox, elimination, addition, substitution, ...
- sugars, carbonic acids, ester, amines

Organic Chemistry (practical course) 56 contact hours

- friedel-crafts acylation of ferrocene
- combinatorial synthesis of esters and polypeptides
- synthesis of bromocamphor

Basics of Biology

7 CPs

Basic Biology (lecture): 70 contact hours

Cell & Molecular Biology

- cell compartments & function
- replication, transcription, translation
- structures of bacteria, viruses and fungi
- membranes & transport
- protein sorting
- signal transduction

Basics of Biochemistry

- amino acids, peptides, proteins, enzymes, carbohydrates, nucleotides, fatty acids, functional groups
- glycolysis, oxidative decarboxylation, citric acid cycle, oxidative phosphorylation, fatty acids, synthesis and degradation, photosynthesis, Calvin cycle

Anatomy

- classification and structure of tissues: muscles, nerves, epithelia and connective tissue
- anatomy of the kidneys, the respiratory tract, the brain, sensory organs, digestive tract and circulation

Mathematics and Computer Science

12 CPs

Mathematics and Computer Science A (lecture and exercises) 68 contact hours

- Basics of logic
- linear algebra – basics, equations, determinants
- informatics
- analysis

Mathematics and Computer Science B (lecture and exercises) 68 contact hours

- integration
- n-dimensional analysis
- common differential equations
- graph theory
- statistics and theory of probability

Basics of Physics

10 CPs

Physics A (lecture and exercises) 68 contact hours

- mechanics
- special theory of relativity
- thermodynamics
- mechanical oscillations and waves
- electrostatics

Physics B (lecture and exercises) 68 contact hours

- magnetism
- electromagnetism
- optics
- quantum mechanics

Physics (practical course) 34 contact hours

- compound pendulum
- oscillography
- speed of sound in air and carbon dioxide
- RC circuit
- optical lenses and microscope
- spectral photometry
- measurement of temperatures
- specific heat capacity of solid objects/water
- viscosity
- statistics and radioactive desegregation
- absorption and dosimetry of x-rays
- calculation of measurement errors

Advanced Biology (140 contact hours)

14 CPs

Cellular Regulatory Mechanisms

- cells and genomes
- cell chemistry and biosynthesis
- proteins
- DNA and chromosomes, replication, repair and recombination
- control of gene expression
- membranes and intracellular transport
- cell communication and signal transduction
- cell cycle and programmed cell death

Immunology

- main concepts
- native immunity
- specific recognition of antigens
- antigen receptors of lymphocytes
- antigen presentation
- signalling in the immune system
- development of lymphocytes
- T-cell mediated immunity
- humoral immunity
- adaptive immunity

Neurobiology

- the structure of the nervous system
- action potential
- synaptic transmission
- neurotransmitter system
- anatomy of the brain
- molecular mechanisms of Learning and Memory
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Recombinant Protein Drugs

- recombinant techniques
- vectors and hosts for recombinant protein production
- recombinant drugs and therapeutic applications

Biology of Evolution

- history of earth, fossils
- methods of evolutionary research
- modes of evolution & speciation
- evolution of different classes of organisms
- evolution of Homo sapiens

Biotechnology of Plants

- physiology
- phytohormones
- cell culture
- photosynthesis
- Green Biotechnology

Tumor Biology

- molecular principles
- classifications
- detection
- treatment, targets

Practical Biology

16 CPs

Biochemistry/Enzymology (practical course) 34 contact hours

- extraction and analysis of proteins
- gel electrophoresis of proteins (SDS-PAGE)
- western blot
- isolation of carbohydrates
- enzyme kinetics of β -Galactosidase from E. coli
- genotyping of CYP2C19

Microbiology (practical course) 34 contact hours

- common techniques in microbiology
- growth of E. coli



- physiological tests
- isolation and quantification of microorganisms
- antibiotics
- bacteriophages

Molecular Biology (practical course) 34 contact hours

- genomic DNA-isolation and plasmid preparation
- agarose gel electrophoresis
- UV-spectroscopy
- PCR
- restriction digest, ligation and cloning
- E. coli transformation
- insert analysis with colony PCR
- sequence analysis
- quantitative PCR
- DNA melting curve
- determination of personal genotype (CYP2C19)

Pharmacology (seminar) 34 contact hours

Seminar presentations by students:

- pathogenesis; treatment of diseases; mechanisms of drug action concerning.
- Selected exemplary topics:
- antiinfectious active agents
- vegetative nervous system
- mediators: histamine and serotonin
- smooth muscles
- heart
- blood
- kidneys
- electrolytes
- digestive tract
- motorical system
- antineoplastical active agents
- nozizeptive system
- endocrine glands

Advanced Chemistry

6 CPs

-Chemistry A (lecture) 23 contact hours

Metalorganic Chemistry, Metal Complexes, Bioorganic Chemistry and Synthesis of Biologically Relevant Compounds

- carbohydrates
- nucleic acids
- amino acids, peptides

Chemistry B (lecture) 23 contact hours

Enzymatic Catalysis

- classification of enzymes
- enzyme kinetics
- inhibition of enzymes
- catalytic strategies
- ribozymes

Physical Chemistry

6 CPs

Physical Chemistry (lecture and exercises) 75 contact hours

- kinetics
- electrochemistry
- thermodynamics

Bioinformatics and Computer methods

8 CPs

Computer methods in Biotechnology (lecture and exercises) 45 contact hours

- sequence analysis: alignments (methods/databases/matrices)
- machine learning
- computer vision
- programming by means of R, interpretation of microarray data
- Python and JAVA programming

Biostatistics (seminar) 23 contact hours

Biotechnical Engineering

6 CPs

Fermentation and fermentation process 75 contact hours

- batch-fermentation of E.coli (practical course)
- Protein-Measurement via Lowry
- computer simulation of fermentation process (seminar and practical course)

Interdisciplinary Skills 60 contact hours[^]

5 CPs

- scientific English and Terminology
- scientific essay writing and presentations skills
- ethical, economic or legal aspects of Molecular Biotechnology (lecture or seminar) (compulsory optional subject)

Internship in the Biotech Industry for at least 6 weeks

7 CPs

Advanced courses (Major and other advanced level courses) (Year 3)

Within the topic chosen as major, two practical course must be attended, the second as an elective course or advanced research project.

Drug Discovery

24/12 CPs

Drug Discovery (lecture) 45 contact hours (68, when chosen as major)

- basic concepts in drug research
- Genomics & functional genomics
- sequencing strategies & techniques
- molecular diagnostics
- assays and targets
- GPCRs and ionchannels
- medical chemistry
- recombinant drugs, biologicals
- cloning
- pharmacology
- cell culture
- active agents

Drug Discovery (practical course) 79 contact hours

One mandatory, current topics can be found online

Bioinformatics

24/12 CPs

Bioinformatics (lecture) 45 contact hours (68, when chosen as major)

- multiple sequence analysis
- hidden markov models
- image analysis
- neural networks
- (multivariate) statistics
- bioinformatical methods in genomics

Bioinformatics (practical course) 79 contact hours

One mandatory, current topics can be found online

Biophysical Chemistry

24/12 CPs

Physical Chemistry (lecture) 45 contact hours

- classical mechanics
- photoelectric effect
- Bohr model of the atom
- uncertainty principle (Heisenberg)
- quantum mechanics
- Schrödinger equation
- wave-particle duality
- fundamentals of molecule spectroscopy

Biophysical Chemistry (lecture) (23 contact hours, only when chosen as major)

- molecular biophysics
- mechanics of DNA
- optical spectroscopy
- physics and chemistry of surfaces

Biophysical Chemistry (practical course) 79 contact hours

One mandatory, current topics can be found online

Bachelor thesis (320 contact hours)
Within the topic chosen as major.

12 CPs

Total Credit points in 3 years

180 CPs