Reutlingen University
School of Life Sciences

Course descritptions for exchange students

Summer Semester 2025

Human Biology 1+2 (Cell Biology)

Study Program **Study level and semester**	BWB Bachelor, 1st semester
ECTS Credits	4 Credits
Hours per week / total contact hours	2 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Dr. Isabel Bughardt Email: Isabel.Burghardt@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Good school knowledge in biological subjects
Course learning objectives:	• Students can identify the components of a cell, name organ systems and can assign basic methods to the different steps of scientific work. • Students will be able to describe the structure and function of human cells using English terminology. • Students will be able to explain basic physiological processes in the human body (digestion, respiration, etc.). • Students will be able to conduct a literature search using databases and solve laboratory-preparatory computational problems. • Students will be able to identify the underlying mechanisms for important cellular functions (communication, migration, proliferation, cell death). • Students will be able to simplify the functioning of organ systems (cardiovascular, nervous, pulmonary, etc.). • Students will be able to evaluate numerical data sets and generate graphical results from them. • Students will be able to plan the structure of a written scientific paper with the appropriate sections.
Contents:	• Structure of the cell • Functions of the cell components • Communication between cells • Cell proliferation and cell death • Hematopoietic system and immune system • Structure and function of different organ systems with the following

	emphases: - Cardiovascular system - Nervous system - Respiratory system - Nutrition and digestion - Excretion - Reproduction • Scientific documentation (laboratory journal, reports) • Scientific research (databases) • Scientific publications • Basic laboratory (calculation of concentrations, dilutions, etc.)
Textbooks:	1. Lodisch H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D., Darnell j.E.: Molekulare Zellbiologie; Spektrum Akademischer Verlag 2. Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts, Walter: Lehrbuch der molekularen Zellbiologie; Wiley-VCH 3. Karp G., Beginnen K., Vogel S., Kuhlmann-Krieg S.: Molekulare Zellbiologie, Springer-Lehrbuch 4. Silbernagel S, Despopoulus A: Taschenatlas Pysiologie, Thieme ISBN 978-3-13-567708-8 5. Schmidt RF, Lang F, Heckmann M: Physiologie des Menschen, Springer, ISBN 978-3-662-54121-0 6. Sobotta, J., Welsch, U: Atlas Histologie: Zytologie, Histologie, Mikroskopische Anatomie Urban & Fischer Verlag/Elsevier GmbH ISBN-10: 3437431412 7. Kremer BP, Bannwarth H.: Einführung in die Laborpraxis, Springer, ISBN 978-3-642-54334-0
Assessment	Written exam (2h)

Biophysical Chemistry

Study Program **Study level and semester**	BWB Bachelor, 2nd semester
ECTS Credits	5 Credits
Hours per week	4
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German & English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev Email: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Mathematics and Physics for chemists. Inorganic Chemistry
Course learning objectives:	After successfully completing the module, students will be able to: • Understand the basic knowledge of physical chemistry in the areas of thermodynamics, chemical thermodynamics, chemical kinetics, mixed-phase thermodynamics, and phase diagrams, and "mass transport • Identify fundamental physical-chemical principles and methods • Define the theoretical background of the relationship between chemical structures and the macroscopic properties of substances • Simplify complex problems using scientific working methods in physical chemistry • Competently evaluate physical-chemical measurement techniques and evaluation methods based on the acquired knowledge • Independently formulate and answer challenging questions
Contents:	Fundamentals in thermodynamics • The first law. System and surrounding. Temperature and 0th law. Work and heat. Internal energy and enthalpy. State functions. Calorimetry. Physical and chemical change. Thermochemistry (Hess's law, Kirhhoff's law). • Ideal gas. Equation of state. Kinetics theory of gases. Real gas. • The second law. Entropy. Direction of spontaneous reactions. Absolute entropy – the third law. Molecular interpretation of the second and the third law. The Boltzmann formula. Gibbs energy.

	• Biological relevance. Energy conversion in organisms. Molecular interactions in biological systems. Calorimetry of the interaction drug-protein. Phase equilibria. • Thermodynamics of transitions. Phase diagrams. Mixtures. The chemical potential. • Colligative properties – osmosis, Donnan equilibrium, Ebullioscopy and Cryoscopy. • Biological relevance. Phase transitions in biological systems – Lipids, Proteins, DANN. Systems at equilibrium. • The reaction Gibbs energy. Equilibria constant. Standard reaction Gibbs energy. The response of the equilibrium to the conditions. • Proton equilibria. pH. Salt solutions. Buffers. • Biological relevance. Biologically significant buffers. Buffer action of blood. Binding of oxygen to haemoglobin. Biosynthesis of proteins. Oxidation of glucose. Ion and electron transport • Ions in solutions. Activity. Debye-Hückel theory. • Redox reactions. Reactions in electrochemical cells. Types of electrodes. Ion selective electrodes. Nernst equation. Standard potential. Electrochemical work. Electrochemical series. • Biological relevance. Membrane potential. Biological redox reactions. Systems in transition • The rates of reactions. Reaction rate. Rate laws. Rate constants. Reaction order. Reaction mechanisms. Dependence on the concentration. Temperature dependence of the chemical reactions – Arrhenius equation. • Catalytically reactions. Bio catalysis – Enzymatic reactions. Michaelis-Menten mechanism. • Diffusion. 1st and 2nd Fick's law. Diffusion coefficient. Permeability. • Biological relevance. Pharmacokinetics. Protein folding and unfolding. • Structures of bio molecules. Chemical bonds. • Fundamentals in structural clarification of biomolecules. Electron microscopy. Spectroscopy.
Textbooks:	1. P. Atkins, J. de Paula Physical Chemistry for the Life Sciences, Oxford University Press. 2. P. Atkins, J. de Paula Atkins' Physical Chemistry, Oxford University Press 3. G. Wedler, H. –J. Freund Lehrbuch der Physikalischen Chemie, Wiley-VCH

	4. C. Czeslik, H. Seemann, R. Winter Basiswissen Physikalische Chemie, Vieweg+Teubner Verlag | Springer
Assessment	Written exam

Biochemistry

Study Program **Study level and semester**	BWB Bachelor, 3rd Semester
ECTS Credits	5
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Ebru Ercan Herbst Email: Ebru.Ercan_Herbst@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basic knowledge of organic and physical chemistry
Course learning objectives:	After successfully completing the module, students will be able to: • Gain basic knowledge of the chemical properties of the various classes of biochemical substances, e.g., amino acids, proteins, carbohydrates, lipids, and nucleic acids • Understand enzymatic processes, describe enzyme reactions, and understand their applications in diagnostics • Understand the principles of action of selected pharmaceuticals • Understand complex biochemical processes, e.g., transcription, translation, and replication, and understand their progression • Understand the control and regulation of metabolic processes • Understand the laws of metabolism and evaluate them for selected metabolic pathways • Understand molecular recognition and non-covalent bonds as a fundamental principle of biochemistry and evaluate their application in diagnostics • Based on the Competently evaluate biochemical facts and the methods based on them using acquired knowledge • Independently formulate challenging analytical questions and answer them by selecting suitable analytical methods
Contents:	• Fundamentals of Biochemistry

	• Amino acids: general chemical properties, chirality, structures of genetically encoded amino acids • Peptides: peptide bonds, nomenclature • Proteins: protein structure, structure, and chemical properties • Enzymes: nomenclature, thermodynamics of enzymatic reactions, enzyme kinetics • Carbohydrates: structure and chemical properties of monosaccharides, oligosaccharides, and glycans, important polysaccharides • Lipids: lipid chemistry, micelles, lipid bilayers, biological cell membranes, transport phenomena across cell membranes • Nucleic acids: structure and properties of nucleotides, structure and properties of DNA and RNA • Genetic code, transcription, and translation • Replication and PCR • Metabolism • General principles of metabolism • Glycolysis and gluconeogenesis • Citric acid cycle • Oxidative phosphorylation • Photosynthesis • Signal transduction
Textbooks:	1. Methews, Van Holde, Ahern: Biochemistry, 3rd Edition, Addison Wesley Longman 2. Horton, Moran, Ochs, Rawn, Scrimgeour: Principles of Biochemistry, 2nd Edition, Prentice Hall 3. Devlin, T. M.: Textbook of Biochemistry with Clinical Correlation, 4th Edition, Wiley-Liss 4. Voet, D., Voet, J. G.: Biochemie, Wiley-VCH 5. Alberts, Bray, Lewis, Raff, Roberts, Watson: Molekularbiologie der Zelle, Wiley-VCH 6. Lehninger: Biochemie, Wiley-VCH 7. Berg, J. M., Tymoczko, J. L.; Stryer, L.: Biochemie, 4. Auflage, Spektrum 8. Berg, J. M., Tymoczko, J. L.; .Stryer, L.; Freeman, W. H. & Co.:Biochemistry, 6th Edition 9. Garrett, R.H., Grisham, Ch.M.,: Biochemistry, Brooks/Cole, Boston MA
Assessment	Written Exam

Microbiology 1+2

Study Program **Study level and semester**	BWB Bachelor, 3rd Semester
ECTS Credits	5 Credits
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German w/ English handouts
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Jörg Mittelstät Email: Joerg.Mittelstaet@Reutlingen-University.DE
Restrictions (if applicable)	
Prerequisites:	Human Biology (recommended)
Course learning objectives:	• The students learn the microbiological terminology • They recognize the diversity of bacteria, archaea, yeasts and fungi, and understand their structure and metabolic pathways. • Students learn about bioprocess engineering production processes • Students understand the interaction between and microorganisms and are able to assess the risks of working with with microorganisms • Students are able to structure a scientific experiment (controls, unknown sample) • Students will be able to evaluate and interpret demonstrated expirements
Contents:	Microbiology 1 and 2: • Discovery of microbiology • Cell structures • Aerobic and anaerobic catabolic pathways • Biochemical identification • Growth in culture • Beneficial and pathogenic interactions with humans • Microhabitats, dead spaces and biofilms • Hygiene and sterility • Biotechnological production processes (penicillin, enzymes) • Classical scientific experiments, their design, results and discussion

Textbooks:	1. M. T. Madigan u.a.: Brock Microbiology of Microorganisms –Pearson Studium, München 2. G. Gottschalk: Welt der Bakterien, Archaeen und Viren – Wiley-VCH 3. G. Fuchs: Allgemeine Mikrobiologie –Thieme, Stuttgart 4. W. Fritsche: Mikrobiologie. –Spektrum Akademischer Verlag, Heidelberg 5. K. Munk: Taschenlehrbuch Biologie - Mikrobiologie – Thieme, Stuttgart 6. M.L. Shuler u.a.: Bioprocess Engineering Basic Concepts -Prentice Hall International Series 7. W.J.Thieman u.a.: Biotechnologie - Pearson Studium 8. E. Bast: Mikrobiologische Methoden. – Spektrum Akademischer Verlag, Heidelberg 9. Steinbüchel, F. B. Oppermann-Sanio: Mikrobiologisches Praktikum, Springer, Berlin
Assessment	Written exam

Surfaces

Study Program **Study level and semester**	BWB Bachelor, 6th semester
ECTS Credits	3 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	75
Type/Teaching Method	Lecture
Language of instruction	German & English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev Email: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basics of Physics, Chemistry, Physical Chemistry, Material Science and Organic Chemistry
Course learning objectives:	**Expertise:** Mastering the basic skills in Chemistry and Physical Chemistry of surfaces. Surfaces and their biological relevance. Surfaces of biomaterials. Structure and dynamics of biologically relevant molecules at surfaces. **Skills:** Understanding principles and methods relevant to surface characterisation. Understanding the relationship of chemical structures to the macroscopic properties of the surfaces Acquisition of experimental skills for measurement techniques and evaluation methods Applications of scientific working methods Ability for independent scientific work and experimentation **Social skills:** Promoting teamwork in exercises

Contents:	<u>Thermodynamics of interfaces:</u> • Fundamental thermodynamic relations. Definition of a surface. Gibbs energy and surface tension. Gibbs adsorption isotherm. • Liquid surface. Curved liquid surface. Young-Laplace equation. Capillary pressure. • Solid surface. Surface energy. Contact angle. Wetting and dewetting. Super hydrophobic surfaces. Adhesion. Work of adhesion. Adhesive effects – glues. • Methods for measurement of the surface tension and the contact angle. • Biological relevance. Liquids in capillaries. Surfaces of typical biomaterials. <u>Adsorption.</u> • Thermodynamics of adsorption. Adsorption models. Measurements with adsorption isotherms. • Adsorption from gas phase. Adsorption from solutions. • Biological relevance. Protein adsorption. Lipid deposition. <u>Surfactants:</u> • Types of surfactants. • Self-assembling in surfactant systems – micelles, vesicles, liposomes, bilayer lipid membranes. Phase diagrams of lipid systems. • Biological relevance. Cell membranes. Lipid rafts. Charged surfaces. • Electric double layer. Poisson-Boltzmann equation. Stern layer. Grahame. Equation. • Electro capillary and electro kinetic effects. The zeta potential. Electrophoresis. • Biological relevance. Electrophoresis as a method for characterisation of proteins. IEP. IEP focusing. Application topics • Basic methods for surface modifications. Physical. Chemical. Coatings. • Dispersed systems. Stability of the dispersed systems. Interactions between surfaces – electrostatic, van der Waals. • Friction and lubrication. • Washing process. • Flotation and its application in the biotechnology.
Textbooks:	1. H.-J. Butt Physics and Chemistry of Interfaces, Wiley-VCH 2013. 2. Evans, D.F., Wennestrtöm, H. The Colloidal Domain: Wiley-VCH, 1999.

	3. Adamson, A.W., Gast, A.P. Physical Chemistry of Surfaces: Wiley-Interscience, 1997. 4. P. Atkins, J. de Paula Physical Chemistry for the Life Sciences, Oxford University Press. 5. Lyklema, J. Fundamentals of Interface and Colloid Science, Volume 1-3, Academic Press Inc. 2000 6. Wintermantel, E., Ha, S. W.: Medizintechnik: Life Science Engineering. Interdisziplinarität, Biokompatibilität, Technologien, Implantate, Diagnostik, Werkstoffe, Zertifizierung, Business Springer, Berlin; Auflage: 5., überarb. u. erw. A. 2009
Assessment	Written exam

Biomaterials

Study Program **Study level and semester**	BWB Bachelor, 4th semester
ECTS Credits	3 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	75
Type/Teaching Method	Lecture
Language of instruction	German & English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Ralf Kemkemer Email: Ralf.Kemkemer@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basics of Physics, Chemistry, Material Sciences, and Organic Chemistry
Course learning objectives:	Basic knowledge: Materials for biomedical application in in-vitro and in-vivo applications Understanding of technologies for surface modifications for implants and related methods Knowledge of biomedical implant technologies - applications examples and challenges Technical competences: Students are able to understand surface and polymer chemistry technologies and can transfer these to appropriate application in the biomedical field Students are able to identify technical working principles of complex implants Students are able to understand the complexity of tissue-material interaction and can relate this to material properties Students are able to classify the suitability of different materials classes for specific application Students can name limitation of current technologies in the field Social competences:

	Students get an awareness of ethical aspects in the development of medical products.
Contents:	Material aspects of biomaterials and surface technologies Concept of biocompatibility Seite 13 von 28 Medical products and introduction into regulations Examples and applications of biomaterials Micro and nanotechnology, Interaction of cells/tissue with materials
Textbooks:	1. Narayan R.: Biomedical Materials, Springer Publisher, 2009 2. Ratner B.D. et al.: Biomaterial Sciences, Elsevier Oxford, 2012 3. Scientific publications
Assessment	Presentation, Written exam

Cell Culture Technology 1+2

Study Program **Study level and semester**	BWB Bachelor, 4th semester
ECTS Credits	5
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Ebru Ercan Herbst Email: Ebru.Ercan_Herbst@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Human Biology and Fundamentals of Biomedicine, Biochemistry, and Microbiology (recommended)
Course learning objectives:	• Students can describe and understand general methods for handling cell cultures. • They can explain and interpret cell-based testing methods and molecular biological analyses. • Students apply their knowledge to selected examples from the literature and learn to analyze and evaluate scientific lines of argumentation.
Contents:	• Introduction to cell culture technology • Theoretical principles for handling animal cells • Cell-based analytics (cell viability, cytotoxicity tests, fluorescence-based methods) • Nuclear architecture and gene expression • Production of mAbs and recombinant drugs
Textbooks:	1. Alberts, Bray, Lewis, Raff, Roberts, Watson: Molekularbiologie der Zelle, Wiley-VCH 2. Minuth, W. et al.: Von der Zellkultur zum Tissue Engineering, Pabst Science Publishers, ISBN 3936142327

	3. DIN EN ISO 10993-1: Biologische Beurteilung von Medizinprodukten - Teil 1: Beurteilung und Prüfungen im Rahmen eines Risikomanagementsystems 4. DIN EN ISO 10993-5: Biologische Beurteilung von Medizinprodukten - Teil 5: Prüfungen auf In-vitro-Zytotoxizität 5. Luttmann, W. et al.: Der Experimentator IMMUNOLOGIE, Spektrum Akademischer Verlag 6. Wintermantel, E.: Medizintechnik mit biokompatiblen Werkstoffen und Verfahren, ISBN 3540412611 7. Brown,T.A.: Gentechnologie für Einsteiger,3-8274-1302-8 8. Glick, B.R.: Molekulare Biotechnologie, Spektrum Akademischer Verlag, ISBN 3860253786 9. Clark D., Pazdernik N.: Molekulare Biotechnologie, Spektrum Akademischer Verlag, ISBN 978-3-8274-2128-9 10. Dingermann, Th.: Gentechnik Biotechnik, ISBN 3-8047-1597 11. Strachan T., Read A.P.: Human molecular genetics, ISBN: 9780815341499 12. Nordheim A. Knippers R.: Molekulare Genetik, ISBN: 9783134770100 13. Watson J.D., Baker T.A.: Molekularbiologie, ISBN 978-3-8689- 4029-9
Assessment	Written exam

Pharmaceutical Biotechnolgy

Study Program **Study level and semester**	BWB & CNB Bachelor, 4th semester
ECTS Credits	5
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Jörg Mittelstät Email: Joerg.Mittelstaet@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Recommended: Human Biology and Fundamentals of Biomedicine, Biochemistry, Microbiology, Cell Culture Technology
Course learning objectives:	• Students acquire knowledge of methods and techniques in pharmaceutical biotechnology and its industrial implementation • Students acquire knowledge of regulatory requirements for the development, approval, and production of pharmaceutical biotechnology products and their industrial implementation • Students understand the process engineering principles in pharmaceutical biotechnology and their applications • Students understand the fundamentals of the development and production of biologics and biosimilars, ATMPs, and their mode of action • Students understand the relevance of quality and risk management and their significance in the pharmaceutical and medical device industries
Contents:	• Overview of biopharmaceutical drug classes such as monoclonal antibodies, vaccines, peptides, proteins, and RNA/DNA. • GMP and quality management, QbD, validation, genetic engineering safety, and regulations. • Methods for purification and characterization/analytics. • Methods in R&D and manufacturing of biopharmaceuticals, process engineering principles, upstream and downstream processing. • Biotechnological processes, cell models.

	• Practical case studies. • Fundamentals of regulatory approval procedures.
Textbooks:	1. Bechthold, A. Pharmazeutische Biotechnologie kompakt, wissenschaftliche Verlagsgesellschaft, 2013 2. Bauer, Frömming, Führer: Pharmazeutische Biotechnologie: Eine Einführung in die Biopharmazie und Biotechnologie, 2016, Wissenschaftliche Verlagsgesellschaft Stuttgart 3. Dingermann, Winckler, Zündorf: Gentechnik, Biotechnik - Grundlagen und Wirkstoffe, 2019, Wissenschaftliche Verlagsgesellschaft Stuttgart 4. Varied current publications
Assessment	Written exam

Project Laboratory BioMED

Study Program **Study level and semester**	BWB Bachelor, 6th semester
ECTS Credits	5 Credits
Hours per week / total contact hours	6 / 90
Total hours of study	150
Type/Teaching Method	Laboratory, Project work etc.
Language of instruction	German or English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Ralf Kemkemer; Kiriaki Athanasopolu Email: Ralf.Kemkemer@Reutlingen-University.DE Kiriaki.Athanasopulu@Reutlingen-University.DE
Restrictions (if applicable)	Admission capacity for this course is limited to max. 5 international students
Prerequisites:	Organic Chemistry, Polymer Chemistry, Human Biology, Medical Basics
Course learning objectives:	The lab is organized as a project orientated learning lab. Students will plan, work and present important aspect of their project in teams. Students will learn • To develop a research project in the field of biomaterials • To write a project proposal and report • To understand and apply physical and chemical methods and technologies for surface modifications and characterization • To understand and apply in vitro methods for testing of biocompatibility • To apply principles of project management • To work in a team on a research project • To analyse, interpret, visualize and present data • To search, read and interpret scientific publications
Contents:	Scientific project management methods, various methods of material sciences, material characterization, cell biology, and related methods. Application of surfaces and surface modifications, technical principles micro and nanotechnology, surface chemistry, interaction of cells with materials.
Textbooks:	Scientific publications

Assessment	Lab work, presentations, project proposal and report

Bioanalysis

Study Program **Study level and semester**	BWB Bachelor, 6th semester
ECTS Credits	5
Hours per week / total contact hours	2 / 30
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German & English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Gunther Proll Email: Guenther.Proll@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Good knowledge of instrumental analysis and statistical data analysis as well as basic knowledge of physical chemistry
Course learning objectives:	After successfully completing the module, students will be able to: • understand complex instrumental analytical methods, e.g., MS and NMR, and understand their application in bioanalytics. • understand the most important bioanalytical methods and evaluate their applications in a wide variety of bioanalytical areas. • independently formulate challenging analytical questions and answer them by selecting suitable analytical methods. • collect, present, and statistically evaluate analytical data. • develop suitable sampling scenarios. • develop solution strategies for bioanalytical problems based on the knowledge acquired.
Contents:	**Bioanalytics I Lecture Content:** • Fundamentals of analytics: sampling, validation of analytical methods • Protein purification and protein determination • Enzyme kinetics • Liquid chromatography in bioanalytics • Electrophoresis of proteins and nucleic acids: SDS-PAGE, IEF, 2D gel electrophoresis, capillary electrophoresis • Amino acid analysis

	• Immunoassays, Western blots • DNA sequencing • Polymerase chain reaction <u>**Bioanalytics II Lecture Content:**</u> • Carbohydrate analysis • Lipid analysis • Mass spectrometry in protein analysis: Ionization techniques, mass analyzers, coupled systems • NMR spectroscopy including 2D NMR • Determination of molecular interactions, kinetic and thermodynamic characterization • Enantiomer separation
Textbooks:	1. Jens Kurreck, Joachim W. Engels, Friedrich Lottspeich, Bioanalytik, Springer-Verlag GmbH (2022) 2. Georg Schwedt, Analytische Chemie, Georg Thieme Verlag Stuttgart 1995 3. Georg Schwedt, Taschenatlas der Analytik, Wiley-VCH Verlag GmbH & Co. KGaA Weinheim 2007 4. M. Otto, Analytische Chemie, Wiley-VCH Verlag GmbH & Co. KGaA Weinheim 2019 5. K. Cammann, Instrumentelle Analytische Chemie, Spektrum Akademischer Verlag GmbH Heidelberg 2001 6. Gey, M., Instrumentelle Analytik und Bioanalytik: Biosubstanzen, Trennmethoden, Strukturanalytik, Applikationen, SpringerLehrbuch, Heidelberg, 2008 7. KE Geckeler, H Eckstein, Bioanalytische und biochemische Labormethoden, Vieweg 8. WMA Niessen, Liquid Chromatography - Mass Spectrometry, Marcel Dekker 9. C Mühlhardt, Der Experimentator: Molekularbiologie/Genomics, Spektrum Akad. Verlag 10. H Rehm, Der Experimentator: Proteinbiochemie/Proteomics, Spektrum Akad. Verlag 11. MF Chaplin, JF Kennedy, Carbohydrate Analysis, Oxford University Press 12. R Matissek, G Steiner, M Fischer, Lebensmittelanalytik, Springer Verlag 13. H Scherz, G Bonn, Analytical Chemistry of Carbohydrates, Thieme Verlag
Assessment	Written exam

Mathematical Principles

Study Program **Study level and semester**	CNB Bachelor, 1st semester
ECTS Credits	5
Hours per week / total contact hours	4 / 90
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Marc Brecht Email: Marc.Brecht@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Good knowledge of high school mathematics
Course learning objectives:	Acquisition of relevant mathematical knowledge for biology and natural sciences: • Students are familiar with the quantities and approaches relevant to understanding mathematical relationships and ways of thinking • Students have a basic understanding of the approach to mathematical problems in the life sciences and can classify them accordingly • Students are familiar with mathematical solution methods for various problems and can implement them or solve them • Students are able to apply the acquired knowledge to unfamiliar mathematical problems in the biomedical sciences then analyze and solve them
Contents:	• Review of mathematical principles • Vector algebra • Functions and curves • Differential calculus • Integral calculus
Textbooks:	1. Horstmann, D.: Mathematik für Biologen, Springer Spektrum, 2 Auflage, 2016. 2. Papula, L.: Mathematik für Ingenieure und Naturwissenschaftler, Band 1, Springer Vieweg; Auflage: 14, 2014

	3. Papula, L.: Formelsammlung Mathematik, Springer Vieweg; Auflage: 12, 2017
Assessment	Written exam, continuous assessment

Analytics and Quality

Study Program **Study level and semester**	CNB Bachelor, 2nd semester
ECTS Credits	5 Credits
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German and/or English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Daniela Almeida-Streitwieser Email: D.Almeida_streitwieser@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	General inorganic and analytical chemistry, basic computer and excel skills (recommended)
Course learning objectives:	Upon successful completion of the module, students will be able to: • independently formulate analytical questions and name suitable analytical methods • list the individual steps of sampling, sample preparation, measurement, evaluation and validation • understand the theoretical background and the functioning of different instrumental techniques and compare them with regard to their properties • compare possibilities and limitations of analytical methods • to transfer analytical problems into analytically solvable measurement tasks taking into account chemical and physical influencing factors • analyze measurement results of different methods on the basis of the acquired knowledge
Contents:	**Introduction to instrumental analysis** Distinction between instrumental methods and classical analytical methods /categorization. Formulation of analytical problems, analytical process and analytical planning. Analytical instruments: signal generation, operational amplifiers, measurement of signals and signal processing. Experimental errors, propagation of measurement uncertainties, statistics. Sampling and sample preparation of gaseous, liquid and solid samples including digestion, preconcentration, and extraction methods. Measurement data

	evaluation, quantification, presentation of results in final reports. Quality management in analytics, auditing, certification and accreditation **Fundamentals of spectral analytical methods:** Properties of electromagnetic radiation and interaction with matter (spectra types). Light sources, spectrographs, monochromators, interferometers, resolving power, luminous intensity and detectors. Atomic spectroscopy - atomization, influence of temperature, apparatus, interference. **Fundamentals of electroanalytical methods:** Electrolysis, polarization and overvoltage, Nernst's equation, Ion mobility, ionic conductivity, limiting conductivity. Set-up of an electroanalytical experiment: cell, three-electrode arrangement, regulation and control of potential or current.
Textbooks:	1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of instrumental analysis. Cengage Learning 2. Harris, D. C. (2010). Quantitative chemical analysis. Macmillan 3. Holler, F. J., & Crouch, S. R. (2013). Applications of Microsoft Excel in Analytical Chemistry. Cengage Learning 4. De Levie, R. (2001). How to Use Excel® in Analytical Chemistry: and in General Scientific Data Analysis. Cambridge University Press
Assessment	Written exam

Lab: Sustainable Chemistry

Study Program **Study level and semester**	CNB Bachelor, 3rd semester
ECTS Credits	8 Credits
Hours per week / total contact hours	9 / 135
Total hours of study	240
Type/Teaching Method	Laboratory
Language of instruction	German
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Mr. Ralf Koslik Email: Ralf.Koslik@Reutlingen-University.DE
Restrictions (if applicable)	Passed written safety colloquium at start of the lab
Prerequisites:	General & analytical chemistry, fundamentals of instrumental analysis, organic chemistry (recommended)
Course learning objectives:	The students are able to: • plan synthesis methods discussed in the lectures Organic Chemistry I and II on a laboratory scale, practically • carry out and master the experimental skills as well as the work-up and purification methods • identify important organic chemical classes of substances, their properties, reactions and reaction mechanisms • master simple and more difficult working methods (working under moisture exclusion, handling hazardous substances) • understand characterization methods of organic products • understand the application of suitable analytical methods for the identification and purity determination of organic products (spectroscopy and chromatography) • evaluate the success of organic syntheses on the basis of spectroscopic and gas chromatographic analyses carried out by themselves • carry out experiments in compliance with safety regulations • handle chemicals (hazardous substances), waste and equipment properly, • record their experiments and work accurately and comprehensibly

Contents:	The lab begins with an introductory session, safety briefing, and equipment course. Before starting the practical work, a written entrance colloquium (safety colloquium) must be completed successfully.
Textbooks:	1. Hünig et.al.: Arbeitsmethoden in der Organischen Chemie, Verlag Lehmanns Media 2. https://www.mygreenlab.org/uploads/2/1/9/4/21945752/a_guide_to_green_chemistry_experiments_for_undergraduate_organic_chemistry_labs_march_2018_v2.pdf 3. Schwetlick: Organikum, Wiley-VCH 4. Brückner et al.: Praktikum Präparative Organische Chemie, Band 1 5. Organisch Chemisches Grundpraktikum, Spektrum Akademischer Verlag 6. Otto, M.: Analytische Chemie, Wiley-VCH, Weinheim (2011) Internship documents are handed over upon registration for the internship and are also available on the university intranet
Assessment	Lab work

Mathematics & Computer Applications

Study Program	CNB
Study level and semester	Bachelor, 3rd semester
ECTS Credits	4
Hours per week / total contact hours	5 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Marc Brecht Email: Marc.Brecht@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	None
Course learning objectives:	• Students are familiar with the mathematical definitions covered in the lecture and understand the concepts, models, and procedures required for modeling in parallel or later in applied subjects. • Students can identify the corresponding mathematical models for technical problems and determine the desired quantities using appropriate calculation methods. • Students are familiar with solution strategies for mathematical problems. • Students can break down complex issues into simpler problems, distinguish between cases, and approach the solution systematically.
Contents:	• Linear algebra: vectors, matrices, determinants, eigenvalues, and eigenvectors • Complex numbers: introduction, definition, and representation of complex numbers; basic arithmetic for complex numbers; powers and roots; applications • Ordinary differential equations: the term "differential equation"; first- and second-order differential equations; solution methods: separation of variables, substitution, eigenvalue method; applications • Laplace transformation: definition and properties, application: solving differential equations

	• Functions of several variables: concept of function, continuity; partial derivative; directional derivative, gradient; tangent plane; total differential; relative extrema; plane domain integrals; spatial domain integrals • Fourier series: Fundamentals of sequences and series, convergence criteria, power series expansion, real and complex representations of Fourier series, calculation of Fourier coefficients, and representation in amplitude-frequency diagrams • Introduction to the fundamentals of computer-aided data processing • Computer-aided representation and analysis of scientific data
Textbooks:	1. Papula, L.: Mathematik für Ingenieure und Naturwissenschaftler, Band 2, Springer Vieweg; Auflage: 14, 2015 2. Papula, L.: Formelsammlung Mathematik, Springer Vieweg; Auflage: 12, 2017
Assessment	Written exam, continuous assessment

Environmental Analysis

Study Program **Study level and semester**	CNB Bachelor, 6th semester
ECTS Credits	6
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture + Lab
Language of instruction	English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Daniela Almeida Streitwieser Email: D.Almeida_streitwieser@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Knowledge of analytics & quality (recommended)
Course learning objectives:	Upon successful completion of the module: • Students will be familiar with the most important environmental chemistry principles, tools, and relationships and will be able to explain them. They will understand the chemical processes important for the environment and the associated cycles. They will be able to independently place, link, and expand this specialist knowledge within a complex context. • Students will recognize the processes that lead to the spread and transformation of chemical substances in the living and non-living environment. They will be able to analyze the environmental impacts of substances from both natural and anthropogenic sources and draw conclusions about the interactions between the lithosphere, hydrosphere, and atmosphere with humans, animals, and plants. • Students will be familiar with selected methods and techniques of environmental analysis in theory and practice and will recognize the integral integration of environmental analysis into environmental law. They will be able to analyze the impact of current environmental pollution on the three systems of lithosphere, hydrosphere, and atmosphere and assess their global consequences. • Students can use environmental analysis as a tool for the objective assessment of environmental conditions and derive the chemical consequences of environmental pollution on the environment.

	• The content is taught through interactive lectures, exercises, and experimental labs. The lecture structure is based on the content of the lecture notes. Keynote presentations are used to convey the content. Numerous practical examples are used to explore real-life issues in the subject area. • During the experimental laboratory sessions, students learn, in small groups, the most important techniques for the analysis and evaluation of environmental parameters in water, air, and soil samples. The analysis and transfer of specialist knowledge is assessed through a preliminary examination in the form of a report and an oral presentation.
Contents:	<u>Fundamentals of Environmental Analysis</u> - Introduction to environmental chemistry: historical development, contamination from anthropogenic activities, environmental awareness - Legal framework of environmental analysis - Importance and challenges of sampling and preserving environmental samples - Sample preparation and measurement using selected environmental analytical methods in environmental compartments: e.g., water (drinking water, wastewater), soil (soil, food), air (outdoor air, indoor air), humans (human samples, forensics) <u>Environmental Analysis Laboratory</u> - Determination and evaluation of analytical parameters - Analytical recording of standing or flowing waters - Determination of environmental contamination in soil samples - Analysis of air pollutants or diffuse greenhouse gases
Textbooks:	1. Bliefert, Claus; (2010): Umweltchemie, Wiley - VCH, Weinheim 2. Hites, Ronald A.; Raff, Jonathan D. (2017): Umweltchemie - Eine Einführung mit Aufgaben und Lösungen, Wiley - VCH, Weinheim 3. Fent, Karl (2013): Ökotoxikologie, Thieme, Stuttgart 4. Koß, Volk (2012): Umweltchemie, Springer, Berlin 5. Rump H. (1998): Laborhandbuch für die Untersuchung von Wasser, Abwasser und Boden, Wiley-VCH, Weinheim 6. Schwedt, G. (1995): Mobile Umweltanalytik. Vogel, Würzburg 7. Schwedt, G. (2004): Analytische Chemie. Wiley-VCH Weinheim 8. Schwedt, G. (2007): Taschenatlas der Analytik. Thieme, Stuttgart
Assessment	Project/lab work, written exam

New Technologies & Future Topics

Study Program **Study level and semester**	CNB Bachelor, 6th semester
ECTS Credits	5
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Marc Brecht; Prof. Dr. Ralf Lehnert Email: Marc.Brecht@Reutlingen-University.DE Ralph.Lehnert@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	None
Course learning objectives:	After successfully completing the course, students will be able to: • understand and generalize important examples from hydrogen technology, energy storage systems, catalysts, surfaces, and colloids. • handle typical properties of these systems and apply them to analytical problems. • predict the composition and properties of different sustainable systems and technologies using visualization techniques. • identify and classify basic types of technologies and make suggestions for sustainable optimization and use. • acquire relevant process analytical knowledge for biology and natural sciences. • understand the tasks, methods, organization, and economic significance of material-based industrial process analysis. • understand the interrelationships of process analysis as part of process development, as well as quality testing and quality assurance in industrial environments. • compare the possibilities and limitations of process analytical measurement principles for different problems.

	• translate analytical problems into analytically solvable measurement tasks, taking chemical and biological factors into account. • develop how measurement results from various methods can be analyzed and evaluated based on the knowledge they have acquired.
Contents:	<u>Introduction to Hydrogen Technology</u> • Fundamentals of hydrogen production • Hydrogen storage and transport • Hydrogen applications (e.g., fuel cells, combustion engines) • Modern energy storage systems – fundamentals and ways to optimize them. Required materials. <u>Energy Storage Technologies</u> • Mechanical storage (e.g., pressure storage) • Electrochemical storage (e.g., batteries) • Thermal storage (e.g., heat storage) • Mechanical storage (e.g., flywheel storage) <u>Use of Hydrogen and Energy Storage in the Energy System</u> • Role of hydrogen and energy storage in the energy transition • Integration of hydrogen and energy storage into existing energy systems • Energy efficiency and sustainability <u>Practical Application of Hydrogen and Energy Storage</u> • Technical requirements and challenges in the use of hydrogen and energy storage • Examples of concrete applications and projects • Economic aspects and market potential <u>Future Developments and Research</u> • Trends and developments in hydrogen and energy storage research • Potential for further technological development • Challenges and opportunities for practical implementation • Strategies for knowledge-based products and processes • Economic assessment and project management of process analytics • Process analytics of solids and surfaces • Process analytics of liquids and gases • Product property design in biotechnology • Product feature design in the pharmaceutical industry
Textbooks:	1. L. M Gandia, G. Arzamendi, P.M Dieguez (Eds.) Renewable Hydrogen Technologies: Production, Purification, Storage, Applications and Safety Elsevier Science 2013 2. K. S. V. Santhanam et al Introduction to Hydrogen Technology Wiley 201 3. R. Huggins Energy Storage: Fundamentals, Materials and Applications Springer 2015 4. R. Neugebauer (Ed.), Wasserstofftechnologienm , Springer, 2022 5. Kessler, R. W. (Ed.). (2012). Prozessanalytik: Strategien und Fallbeispiele

	aus der industriellen Praxis. John Wiley & Sons. 6. Bakeev, K. A. (Ed.). (2010). Process analytical technology: spectroscopic tools and implementation strategies for the chemical and pharmaceutical industries. John Wiley & Sons. 7. Beg, S., & Hasnain, M. S. (Eds.). (2019). Pharmaceutical quality by design: principles and applications. Academic Press. 8. Jameel, F., Hershenson, S., Khan, M. A., & Martin-Moe, S. (Eds.). (2015). Quality by design for biopharmaceutical drug product development (Vol. 18). Springer.
Assessment	Presentation/poster, written exam

Bioeconomy

Study Program **Study level and semester**	CNB Bachelor, 6th semester
ECTS Credits	5
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	German or English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Daniela Almeida Streitwieser Email: D.Almeida_streitwieser@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Sustainable processes, sustainable chemistry, polymer-based materials (recommended)
Course learning objectives:	The students: • know and understand the interrelationships in the field of bioeconomy • Know the most important processes within the bioeconomy • Are familiar with evaluation scenarios
Contents:	• Definition and holistic concept of the bioeconomy • Economic relationships • Classification of biorefineries (lignocellulose-based biorefineries, whole-crop biorefineries, thermochemical processing, green biorefineries; fermentation of plant juices, wet mill/dry mill processes) • In-depth discussion of biocatalytic and microbiological processes (white biotechnology) • In-depth discussion of important biomass-based processes (lignin, starch) • Production of bioenergy and biofuels • Production of materials and chemicals (product families) • Process examples for biorefineries based on various feedstocks • Technical aspects of waste and residue utilization • Introduction to the concepts of the circular economy • Cradle-to-cradle concept • Case studies
Textbooks:	1. Pietzsch J (2017) Bioökonomie für Einsteiger. Springer. ISBN 978-3-662-53762-6.

	2. Thrän D, Moesenfechtel (2020) Das System Bioökonomie, Springer, ISBN 978-3662-6072-99 3. Kranert M (2018) Einführung in die Kreislaufwirtschaft, Springer Vieweg, ISBN 978-3-8348-1837-9 4. Kircher M, Schwarz T (2020) CO2 und CO – Nachhaltige Kohlenstoffquellen für die Kreislaufwirtschaft. Springer, ISBN 978-3-662-60648-3. 5. Kamm B, Gruber P, Kamm M (2010) Biorefineries – Industrial Processes and Products. Status Quo and Future Directions, ISBN 978-3527-3295-33
Assessment	Written exam

Study Project

Study Program **Study level and semester**	Any Bachelor or Master
ECTS Credits	2 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	60
Type/Teaching Method	Project work
Language of instruction	German or English
Frequency	Summer semester, Winter semester
Course Coordinator/Instructor	Various (topic dependent)
Restrictions (if applicable)	Subject to availability
Prerequisites:	None
Course learning objectives:	The student will work on a small project independently.
Contents:	Each project is to be discussed on an individual basis.
Textbooks:	TBD
Assessment	Project work

Analytical Methods in Biomedical Science

Study Program **Study level and semester**	BMS Master, 1st Semester
ECTS Credits	2
Hours per week / total contact hours	2 / 30
Total hours of study	75
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Winter semester
Course Coordinator/Instructor	Prof. Dr. Jörg Mittelstät; Prof. Dr. Günther Proll Email: joerg.mittelstaet@reutlingen-university.de guenther.proll@reutlingen-university.de
Restrictions (if applicable)	None
Prerequisites:	Knowledge of biochemistry, bioanalytics, instrumental analytics, chemistry, material science, and biology is recommended
Course learning objectives:	**General knowledge:** Successful students will obtain: • Profound overview of current bioanalytical techniques that are significant in biomedical and pharmaceutical research • Profound understanding of materials for diagnostic applications • Profound understanding of technologies and functioning of laboratory diagnostics, point-of-care testing and applications • Fundamental understanding of principles of cell biology, and molecular biology **Skills:** • Understanding of complex relationships in bioanalytics • Understanding of the aspects of -OMICS that are relevant for R&D in biotechnology, pharmaceutical and diagnostics industries • Understanding of principles of interaction of biological systems and molecules with materials • Understanding of principles of structure of diagnostic systems and prerequisites for certain applications • Ability to name limitations of existing technologies • Ability to evaluate various methods of laboratory diagnostics • Ability to read and understand scientific publications

	<u>Social competences:</u> • Ability to prepare and deliver a scientific presentation for a seminar • Ability to do scientific research and to present scientific findings
Contents:	The course consists of a lecture and a seminar. Students must choose a research topic on which they will prepare and hold a scientific presentation. The following fields of study will be covered in the lecture and seminar: • Biomarkers • Proteomics and metabolomics • Pharmaceutical analysis
Textbooks:	1. Jens Kurreck, Joachim W. Engels, Friedrich Lottspeich, Bioanalytik, Springer-Verlag GmbH Berlin 2022 2. Albert Folch, Introduction to BioMEMS, CRC Press (2013) 3. Peter Luppa, POCT - Patientennahe Labordiagnostik, Springer (2017) 4. Strachan T, Read AP, Matson RS, Human Molecular Genetics, CRC Press (2018). 5. Barh D, Blum K, Madigan MA, OMICS – Biomedical Perspectives and Applications, CRC Press (2012) 6. Rehm, H., Letzel, T.: Der Experimentator – Proteinbiochemie/Proteomics, Spektrum Verlag 7. Scientific publications
Assessment	Presentation, written exam

Materials and Applications in Biomedical Science

Study Program **Study level and semester**	BMS Master, 1st semester
ECTS Credits	5 Credits
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Winter semester
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev Email: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basic understanding of chemistry, biology and biomedical technology, material sciences
Course learning objectives:	Basic knowledge • Knowledge of materials for biomedical application in in-vitro and in-vivo applications • Understanding of technologies for surface modifications for implants and related methods • Knowledge of biomedical implant technologies - application examples and challenges • Understating of drug delivery concepts and application of polymers • Understanding of drug release methods, kinetics and applications Technical competences: • Students will be able to understand surface and polymer chemistry technologies and transfer these to appropriate applications in the biomedical field • Students will be able to identify technical working principles of complex implants • Students will be able to understand the complexity of tissue-material interaction and relate this to material properties • Students will be able to classify the suitability of different materials classes for specific applications

	• Students will be able to name limitations of current technologies in the field Social competences: • Students develop skills in research, reading and interpretation of scientific texts • Students gain an awareness of ethical aspects in the development of medical products.
Contents:	Functional Implants & Surface Technologies Materials and design principles of passive and active implants, examples and applications, surfaces and surface modifications, technical principles of active implants (examples), micro and nanotechnology, surface chemistry, interaction of cells with materials. Drug Release and Delivery Systems Medical devices (active and passive) as drug delivery systems examples and applications Approaches, formulations, technologies, and systems for transporting of active pharmaceutical compounds as needed to achieve the desired therapeutic effect Immobilisation and delivery of “biologicals” e.g. peptides, proteins, antibodies, vaccines and gene based drugs Release based on diffusion, degradation, swelling, and affinity-based mechanisms Current approaches – site and time specific targeting, facilitated pharmacokinetics Example techniques – thin polymer film delivery, acoustic or light targeted delivery, liposomal delivery.
Textbooks:	1. King M.R.: Principles of Cellular Engineering – Understanding the Biomolecular Interface, Academic Press, 2006 2. Ritter A.B., et al.: Biomedical Engineering Principles, CRC Press, 2012 3. Narayan R.: Biomedical Materials, Springer Publisher, 2009 4. Ratner B.D. et al.: Biomaterial Sciences, Elsevier Oxford, 2012 5. Wintermantel E., H. Suk-Woo Ha: Medizintechnik: Life Science Engineering, Springer 2009
Assessment	Written exam (2h), presentation/assignments

Functional Implants & Surface Technologies

Study Program **Study level and semester**	BMS Master, 1st semester
ECTS Credits	2 Credits
Hours per week / total contact hours	2/30
Total hours of study	75
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Winter semester
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev E-Mail: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basic understanding (BSc-level) of chemistry, biology and biomedical technology, as well as material sciences
Course learning objectives:	**Basic knowledge** • Knowledge of materials for biomedical application in invitro and in-vivo applications • Understanding of technologies for surface modifications for implants and related methods • Knowledge of biomedical implant technologies • application examples and challenges **Technical competences:** • Students will be able to understand surface and polymer chemistry technologies and transfer these to appropriate applications in the biomedical field • Students will be able to identify technical working principles of complex implants • Students will be able to understand the complexity of tissue-material interaction and relate this to material properties •Students will be able to classify the suitability of different materials classes for specific applications - Students will be able to name limitations of current technologies in the field **Social competences:** •Students develop skills in research, reading and interpretation of scientific texts

	• Students gain an awareness of ethical aspects in the development of medical products.
Contents:	Functional Implants & Surface Technologies Materials and design principles of passive and active implants, examples and applications, surfaces and surface modifications, technical principles of active implants (examples), micro and nanotechnology, surface chemistry, interaction of cells with materials.
Textbooks:	3. Schwedt, G.: Taschenatlas der Analytik, Wiley-VCH, 2007 4. Otto, M.: Analytische Chemie, Wiley-VCH Weinheim, 2011 5. Kolb, B.: Gaschromatographie in Bildern, Wiley-VCH Weinheim, 2003 6. Meyer, V. R.: Praxis der Hochleistungsflüssigchromatographie, Wiley-VCH Weinheim, 2009 7. Funk, W., Damann, V. & G. Donnevert: Qualitätssi-cherung in der analytischen Chemie, Wiley-VCH Weinheim, 2005
Assessment	Written exam

Drug Research and Delivery Systems

Study Program **Study level and semester**	BMS Master, 1st Semester
ECTS Credits	3
Hours per week / total contact hours	2/30
Total hours of study	75
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Winter semester
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev E-Mail: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basic understanding of chemistry, biology and biomedical technology, material science (recommended)
Course learning objectives:	**Basic knowledge** • Knowledge of materials for biomedical application in invitro and in-vivo applications • Understanding of technologies for surface modifications for implants and related methods • Knowledge of biomedical implant technologies • application examples and challenges **Technical competences:** • Students will be able to understand surface and polymer chemistry technologies and transfer these to appropriate applications in the biomedical field • Students will be able to identify technical working principles of complex implants • Students will be able to understand the complexity of tissue-material interaction and relate this to material properties •Students will be able to classify the suitability of different materials classes for specific applications - Students will be able to name limitations of current technologies in the field **Social competences:** •Students develop skills in research, reading and interpretation of scientific texts

	• Students gain an awareness of ethical aspects in the development of medical products.
Contents:	•Drug Release and Delivery Systems • Medical devices (active and passive) as drug delivery systems examples and applications •Approaches, formulations, technologies, and systems for transporting of active pharmaceutical compounds as needed to achieve the desired therapeutic effect • Immobilization and delivery of "biologicals" e.g. peptides, proteins, antibodies, vaccines and gene based drugs • Release based on diffusion, degradation, swelling, and affinity-based mechanisms • Current approaches – site and time specific targeting, facilitated pharmacokinetics • Example techniques – thin polymer film delivery, acoustic or light targeted delivery, liposomal delivery.
Textbooks:	1. King M.R.: Principles of Cellular Engineering – Understanding the Biomolecular Interface, Academic Press, 2006 2. Ritter A.B., et al.: Biomedical Engineering Principles, CRC Press, 2012 3. Narayan R.: Biomedical Materials, Springer Publisher, 2009 4. Ratner B.D. et al.: Biomaterial Sciences, Elsevier Oxford, 2012 5. Wintermantel E., H. Suk-Woo Ha: Medizintechnik: Life Science Engineering, Springer 2009
Assessment	Written exam

Drug Discovery & Development

Study Program **Study level and semester**	BMS Master, 1st semester
ECTS Credits	2
Hours per week / total contact hours	2 / 30
Total hours of study	75
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Winter semester
Course Coordinator/Instructor	Prof. Dr. Jörg Mittelstät Email: Joerg.Mittelstaet@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Basic knowledge and understanding of the principles of pharmaceutical and medical technology industries and the natural sciences (recommended).
Course learning objectives:	Understanding of strategic and operational topics concerning drug discovery, drug development, medical and biomedical technologies. In “Drug Discovery and Development”, students will receive information on state-of-the-art developments, research, and expert opinions in the pharmaceutical industry. Furthermore, the key success factors in research and development (R&D) as well as value creators in pharmaceutical innovation will be discussed. The topics addressed include the innovation process, pharmaceutical R&D, research and innovation strategies. Students will gain an overview of the pharmaceutical industry and how pharmaceutical R&D works operationally.
Contents:	• Global epidemiology • Pharma-economics • Financing of innovation • Drug targets • Preclinical safety 30 • Pharmaceutical development • Translational medicine • Clinical development • Biologics and ATMPs • Bioequivalence and Biosimilars • Regulatory considerations • Pharmaceutical strategies

Textbooks:	1. Blass BE, Basic Principles of Drug Discovery and Development,2nd Edition, Elsevier Academic Press, 2021 2. Hill RG, Richards DB, Drug Discovery and Development – Technology in Transition, 3rd Edition, Elsevier. 3. Wintermantel, E., Ha, S. W.: Medizintechnik: Life Science Engineering. Interdisziplinarität, Biokompatibilität, Technologien, Implantate, Diagnostik, Werkstoffe, Zertifizierung, Business Springer, Berlin; Auflage: 5., überarb. u. erw. A. 2009 4. Ratner, B. D., Hoffman A.S. et al. (eds.): Biomaterials Science - An Introduction to Materials in Medicine, Elsevier Academic Press, 2004 5. Joseph Bronzino and Donald R. Peterson: The Biomedical Engineering Handbook, Fourth Edition: Four Volume Set, Crc Pr Inc; 2015 6. Pierre Morgon (2014) Sustainable Development in the Healthcare System, Springer
Assessment	Written exam

Biomedical Technology and Regenerative Medicine

Study Program **Study level and semester**	BMS Master, 2nd semester
ECTS Credits	5 Credits
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Summer semester
Course Coordinator/Instructor	Prof. Dr. Petra Kluger Email: Petra.Kluger@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Cell biology, physiology, biomaterials, tissue engineering, biomedical engineering
Course learning objectives:	• students get insight into biofabrication technologies for future perspectives in biomedical engineering • students get an overview of the materials and techniques used in Regenerative Medicine; state of the art in various clinical applications and the global market students know: • how to define biofabrication • basic principles for automation, especially for automated cell and tissue culture as well as clinical applications • different biofabrication technologies, their characteristics and their pros & cons • needed properties for a bioink, different materials used as bioink and their limitations • possible applications of these biofabrication technologies in biomedical sciences • how to define regenerative medicine • the characteristics of stem cells and their clinical use • different matrix components and their properties as well as the clinical applications of different matrices • the regulatory framework

	• key facts concerning the global regenerative medicine market • the state of the art in selected applications and the challenges students improve their ability in: • understanding and use new vocabulary • read, summarize and discuss about scientific topics prepare and present these results and short presentation in teams
Contents:	• Definition and short summary of fundamentals • Stem cells (basics and clinical applications) • Matrix (basics and clinical applications) • State-of-the-art clinical applications • Regulatory affairs and market
Textbooks:	1. Gustav Steinhoff, Regenerative Medicine: From Protocol to Patient, Springer 2013 2. Anthony Atala, Robert Lanza, James A., Thomson, and Robert M. Nerem, Principles of Regenerative Medicine, Elsevier, 2008 3. Ratner, B. D., Hoffman A.S. et al. (eds.): Biomaterials Science - An Introduction to Materials in Medicine, Elsevier Academic Press, 2004 4. Joseph Bronzino and Donald R. Peterson : The Biomedical Engineering Handbook, Fourth Edition: Four Volume Set, Crc Pr Inc; 2015
Assessment	Written exam

Advanced Pharmacology

Study Program **Study level and semester**	BMS Master, 2nd semester
ECTS Credits	5
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Summer semester
Course Coordinator/Instructor	Prof. Dr. Jörg Mittelstät; Prof. Dr. Günther Proll Email: Joerg.Mittelstaet@Reutlingen-University.DE; Guenther.Proll@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Knowledge of biochemistry, bioanalytics and instrumental analytics, biology, fundamentals of pharmacology (recommended)
Course learning objectives:	<u>General knowledge:</u> • Profound overview of current bioanalytical techniques relevant for biomedical as well as pharmaceutical research • Understanding of mode of action of drugs <u>Skills:</u> • Understanding of drug interaction in the human organism • In-depth knowledge of Pharmaco-kinetics and Pharmaco- dynamics • Understanding of the use of modern analysis systems and biosensors in drug development and personalized medicine • Understanding of the functioning of microarray systems and multiplexing • Ability to read and understand scientific publications <u>Social competences:</u> • Preparation and presentation of a scientific presentation for a seminar • Ability to do scientific research and present scientific findings
Contents:	<u>Analytical Methods in Biomedical Sciences:</u> • Special instrumental analysis • Imaging methods • Biosensors • Characterization of viral vectors • In silico analysis • Automation in drug discovery • Effect-directed analytics

	<u>Biomedical Pharmacology</u> • Fundamentals and Nomenclature in Pharmacology • Pharmacokinetics • Pharmacodynamics • Pharmacology of Thrombosis • Pharmacology of Hypertension • Pharmacology of Pain and inflammation
Textbooks:	1. Jens Kurreck, Joachim W. Engels, Friedrich Lottspeich, Bioanalytik, Springer-Verlag GmbH Berlin 2022 2. Karl Cammann, Instrumentelle Chemie, Spektrum Akademischer Verlag GmbH (2001) 3. Günter Gauglitz, David S. Moore, Handbook of Spectroscopy, Wiley-VCH Verlag GmbH & Co. KGaA (2010) 4. Ullmann`s Encyclopedia of Industrial Chemistry, WileyVCH Verlag GmbH & Co. KGaA (2016)
Assessment	Written exam

Practical Training: Environmental Analysis

Study Program **Study level and semester**	UWS Master, 1st semester
ECTS Credits	2
Hours per week / total contact hours	1
Total hours of study	N/A
Type/Teaching Method	Internship
Language of instruction	German
Frequency	Winter semester; summer semester
Course Coordinator/Instructor	Prof. Dr. Almeida-Streitwieser Email: d.almeida_streitwieser@reutlingen-university.de
Restrictions (if applicable)	None
Prerequisites	None
Course learning objectives:	The students are familiar with selected methods and techniques of environmental analysis in both theory and practice and understand the strong integration of environmental analytics within environmental law. They are capable of analyzing the effects of current environmental pollution on the three environmental compartments—lithosphere, hydrosphere, and atmosphere—and assessing its global consequences. The students can use environmental analysis as a tool for the objective evaluation of environmental conditions and derive the chemical consequences of environmental pollution. The course content is delivered through interactive lectures, exercises, and experimental laboratory work. The lecture structure follows the content of the course script, and impulse presentations are used to introduce key topics. Real-world environmental questions are explored through numerous practical examples of substance transformations and cycles within physicochemical models and calculations. During the experimental laboratory sessions, students work in small groups to learn essential techniques for analyzing and evaluating environmental parameters in water, air, and soil samples. The analysis and application of the acquired knowledge are assessed through a preliminary examination in the form of a written report and an oral colloquium.
Contents:	<u>**Determination and evaluation of analytical parameters**</u> • Analytical recording of a standing body of water and integration of the data into citizen science projects on water quality: measurement of COD, BOD, N and P, among others, partly using photometric test methods

	• Determination of environmental pollution in soil samples: PAH or metal content by means of extraction/elution and subsequent detection using gas chromatography with mass spectrometry or atomic mass spectrometry or atomic absorption spectroscopy • Analysis of air pollutants (SO_2, NO_x) or diffuse greenhouse gases with the aid of gas test tubes, collection bags or by passive collection (surface active monitoring) with subsequent extraction subsequent extraction and analytical determination (IC, FTIR, GC-FID)
Textbooks:	-
Assessment	Lab work

Environmental Chemistry

Study Program **Study level and semester**	UWS Master, 1st semester
ECTS Credits	3
Hours per week / total contact hours	2
Total hours of study	60
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Almeida-Streitwieser Email: d.almeida_streitwieser@reutlingen-university.de
Restrictions (if applicable)	None
Prerequisites:	None
Course learning objectives:	The students are familiar with the fundamental principles, key instruments, and interconnections of environmental chemistry and can explain them. They understand the chemical processes occurring in the lithosphere, hydrosphere, and atmosphere that are relevant to the environment, as well as the associated biogeochemical cycles. They are able to independently integrate, link, and expand this specialized knowledge within a complex context. The students recognize the processes that lead to the dispersion and transformation of chemical substances in both the biotic and abiotic environment. They can analyze the environmental impact of substances from both natural and anthropogenic sources and draw conclusions about the interactions between the lithosphere, hydrosphere, and atmosphere, as well as their effects on humans, animals, and plants. They are aware of the material cycles and energy flows in natural ecosystems and can relate them to anthropogenic and technical systems.
Contents:	1. <u>**Introduction to environmental chemistry:**</u> • Terms and definitions • Historical development • Pollution due to anthropogenic activities • Environmental awareness • Demography 2. <u>**Chemistry of the hydrosphere:**</u> • Properties and chemistry of water (pH, pKs, pKI, etc...) • Water cycle, consumption, water balance • Groundwater, drinking water, waste water

	• Current topics: Pollutants in water (inputs and effects), water scarcity **3. <u>Chemistry of the atmosphere:</u>** • Structure in layers and composition • Global circulation systems • Greenhouse gases, air pollutants • Energy balance, radiation balance, • ozone layer • Current topics: Air quality and pollutants, greenhouse effect and climate change **4. <u>Chemistry of the lithosphere:</u>** • Chemical composition of the earth, structure of minerals • Geochemical cycle: weathering, sedimentation • Soil chemistry, pollutant inputs, soil acidification
Textbooks:	1. Bliefert, C. (2010). Umweltchemie. Weinheim: Wiley – VCH. 2. Hites, R. A. & Raff, J. (2017). Umweltchemie - Eine Einführung mit Aufgaben und Lösungen. Weinheim: Wiley – VCH. 3. Fent, K. (2013). Ökotoxikologie. Stuttgart: Thieme. 4. Koß, V. (2012). Umweltchemie. Berlin: Springer. 5. Rump, H. (1998). Laborhandbuch für die Untersuchung von Wasser, Abwasser und Boden. Weinheim: Wiley – VCH. 6. Schwedt, G. (1995). Mobile Umweltanalytik. Würzburg: Vogel. 7. Schwedt, G. (2004). Analytische Chemie. Weinheim: Wiley – VCH. 8. Schwedt, G. (2007). Taschenatlas der Analytik. Stuttgart: Thieme
Assessment	Written exam

Calculation Methods in Process Engineering

Study Program **Study level and semester**	UWS Master, 1st semester
ECTS Credits	2
Hours per week / total contact hours	2
Total hours of study	90
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	Winter semester; summer semester
Course Coordinator/Instructor	Prof. Dr. Almeida-Streitwieser Email: d.almeida_streitwieser@reutlingen-university.de
Restrictions (if applicable)	None
Prerequisites:	Knowledge of scientific working methods at Bachelor level is required.
Course learning objectives:	The overarching learning objective is the advanced understanding of the scientific process and advanced scientific methods in the natural and engineering sciences, building on the scientific methods at the bachelor level: The students are familiar with the basic structures of scientific work and are able to apply them consistently in project work. They can apply the learned tools and strategies in a task-specific manner to efficiently and goal-oriented address problems. The conveyed scientific theoretical concepts and methods are relevant for all courses in the program and serve as the methodological foundation for the preparation of the master's thesis. The students are able to independently research the state of knowledge and critically assess the quality of literature sources. They understand the tasks related to environmental protection and are able to address these tasks using scientific methods in a targeted manner. They recognize the advantages and disadvantages of different processing methods and can select a meaningful approach based on the application context. They are capable of systematically evaluating third-party processing methods. In this course, students acquire methodological competencies for the systematic handling of scientific questions and for the creation of scientific documents such as the master's thesis. This enables them to systematically research the state of knowledge and categorize the quality of literature sources according to defined criteria. After successfully participating in the course, they will have a fundamental understanding of the systematic planning, execution, documentation, and publication of their own research

	work. The objective of the course is to impart the necessary knowledge and methods for this and their independent application in the context of specific tasks. The students are familiar with the principles of energy and material transport, as well as material transformation. They understand the laws of mass and energy conservation and can apply these through mass and energy balances in closed systems. They understand the division, arrangement, and application of basic operations in environmental engineering and can trace their chemical, physical, or mechanical operating principles. The students are familiar with the arrangements of process engineering plants and understand their operation and associated technical challenges. They know the fundamentals of apparatus engineering and can interpret and explain them through graphical representations. They can apply the process engineering principles of various environmentally relevant systems to the respective task. The students are able to classify the techniques for primary and secondary measures to prevent emissions. They understand the relationship between the plant process engineering, plant operation, and the resulting pollutant minimization. The students understand the physicochemical processes and their dependencies, which are applied in the analysis and treatment of air and other gaseous media. They possess practical experience in the measurement and analysis of gas composition and the functioning of physical and chemical processes for gas treatment. They can assess air quality based on emission concentrations. They understand the role of greenhouse gas emission avoidance for climate protection and have practical knowledge of a process for capturing CO2 from gases and its provision as a pure substance for material recycling. They are able to identify sources of error during experimental execution and concentration determination and can perform the corresponding calculations for experiment evaluation.
Contents:	In this course, after an introduction to engineering calculations, the principles of energy and mass transport as well as principles of energy and mass transfer, as well as mass conversion. The basics of process engineering are presented using a simplified method of mass balancing with block diagrams. are presented. In the second and third steps, the division, arrangement and applications of basic operations in process engineering are presented. process engineering are presented. Plant engineering is explained using the tools of graphical representation, equipment technology and measurement and control technology. Finally, examples of the process and environmental engineering systems and to analyze their technical challenges. analyze their technical challenges 1. <u>Introduction to process engineering</u> • Units and conversion factors • Law of conservation of mass and energy • Material balances and block diagrams

	2. <u>Basic operations in process engineering</u> • Chemical reaction engineering • Thermal separation processes • Mechanical process engineering 3. <u>Plant engineering</u> • Graphical representations (block diagram, process flow diagram, P&I diagrams, layout) • Fundamentals of apparatus engineering (piping, apparatus, control technology) • Basics of measurement and control technology (control loops, sensors) 4. <u>Environmental and industrial processes</u> • Examples of industrial processes (e.g. ammonia, sulphuric acid, etc.) • Examples of environmental processes (e.g. exhaust air purification, waste water treatment)
Textbooks:	1. Klapper, D. et al. (2009): Methodik der empirischen Forschung. Ed. Sönke Albers. Vol. 3. Wiesbaden: Gabler. 2. Forschungsgemeinschaft, DFG. Sicherung guter wissenschaftlicher Praxis. Denkschrift (2013). Weinheim: WILEY-VCH Verlag GmbH & Co KGaA. Abgerufen von: http://doi.org/10.1002/9783527679188.oth1. 3. Behr, A., Agar D.W. & Jörissen, J. (2010). Einführung in die Technische Chemie. Heidelberg: Spektrum Akademischer Verlag. 4. Jess, A. & Wasserscheid, P. (2013). Chemical Technology: An Integral Textbook (1. Ausgabe). Weinheim: Wiley-VCH. 5. Schwister, K. (2017). Taschenbuch der Verfahrenstechnik (5. Auflage). München: Hanser. 6. Schwister, K. (2010). Taschenbuch der Umwelttechnik (2. Auflage). München: Hanser. 7. Reynolds, J. (2002). Handbook of Chemical and Environmental Engineering Calculations (1. Edition). WileyInterscience. 8. Hites, R. (2017). Umweltchemie: Eine Einführung mit Aufgaben und Lösungen, Weinheim: Wiley – VCH. 9. IPCC (2021). Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge (U.K.): Cambridge Univ. Press. 10. Baumbach, G. (2005). Luftreinhaltung. Berlin: Springer-Verlag. 11. Görner, K., Hübner, K. (2001). Gasreinigung und Luftreinhaltung. Berlin: Springer-Verlag. 12. Hess, D., Klumpp, M. & Dittmeyer, R. (2020). Nutzung von CO2 aus Luft als Rohstoff für synthetische Kraftstoffe und Chemikalien, Stuttgart: Studie im Auftrag des Ministeriums für Verkehr Baden-Württemberg. 13. Fischedick, M., Görner, K. & Thomeczek, M. (2015). CO2: Abtrennung, Speicherung, Nutzung: Ganzheitliche Bewertung im Bereich von Energiewirtschaft und Industrie. Berlin: Springer-Verlag.
Assessment	Written exam

Global Environmental Challenges

Study Program **Study level and semester**	UWS Master, 2nd or 3rd Semester
ECTS Credits	5
Hours per week / total contact hours	4
Total hours of study	-
Type/Teaching Method	Lecture
Language of instruction	English
Frequency	Summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Almeida-Streitwieser Email: d.almeida_streitwieser@reutlingen-university.de
Restrictions (if applicable)	None
Prerequisites:	None
Course learning objectives:	Students know the most important international environmental protection organizations and the transnational agreements for the protection of the environment. They can assess where the political hurdles and social and economic challenges involved in approving international agreements and guidelines. They know the goals of sustainable development and can explain them with concrete examples and relate them to possible funding programs. Students know the global environmental challenges and are able to recognize the associated global and local risks. recognize the associated global and local risks. They understand the causes and transnational consequences of uncontrolled growth and environmental pollution. They understand that these challenges through national and international policy, general education and public participation. and public participation. Students are aware of the difference in the economic, ecological and social situation of developing countries compared to industrialized countries, as well as the requirements of the "global South". They can put themselves in the position of other countries and population groups and can analyze these differences and analyze these differences and develop compromise proposals. Students have dealt with the issues surrounding global environmental challenges and can justify their opinions with arguments, e.g: What opportunities and barriers do nations and individuals have to influence the environment? What consequences can be expected from environmental changes to be expected? To what extent is it possible to pollute the

	environment and its capacities? burden? This course will examine the main global environmental challenges, their origins and consequences. consequences. Students will discuss the alternative scenarios and propose short, medium and long-term solutions. and long-term solutions. Students will be able to recognize the risks associated with the environmental challenges recognize the risks associated with environmental challenges and better understand their potential consequences in a global context. This course is taught in English with international collaboration
Contents:	The present course will explore the most significant global environmental challenges, their origin and consequences. It will also discuss the alternatives to seek improvement of the situation and propose solutions in the short, mid, and long terms. In this context the most important international environmental organizations and agreements will be studied, as well as the difficulties associated with the negotiations and agreements. The students will be able to identify the risks associated with the environmental challenges and can understand better their consequences and possible solutions in a global context. **Overview of the international landscape of environmental organizations and initiatives** • National compromises and agreements on environmental issues • Non-governmental environmental organizations • Sustainability: Sustainable Development Goals (SDG's) and Green deal • Other initiatives and public opinion **Current challenges studied from a global perspective** (selection of topics according to students' interest. List without claim of completeness) • Population: demographic growth, public health problems, fast fashion • Food production: efficient use of land, mass food production, genetically modified food, food waste • Water resources management: Water footprint, water scarcity, acid rain, ocean acidification, depletion of polar ice caps and sea level rise • Deforestation, desertification, and biodiversity loss: reduction of biomass due to deforestation, increase of desert land, soil degradation, Reduction of species, Overfishing • Pollution of air, water, soils, and oceans: Sources, consequences and reduction of pollution • Waste management: waste disposal and recycling, plastic and microplastics • Energy sources and demand: renewable energies, fossil fuels, • Natural resource depletion: wood and other raw materials, C, N and P cycles, mining and minerals • Climate change: greenhouse gas emissions inventories, ozone layer depletion, foreseeable consequences of CC • Blue/Green infrastructure and products
Textbooks:	1. Davie T. (2019). Fundamentals of Hydrology (3rd Ed.). Routledge Editorial, ISBN-10: 0415858704, ISBN-13: 978-0415858700

	2. Mihelcic, J., & Zimmerman, J. (2021). Environmental Engineering: Fundamentals, Sustainability, Design (3 rd Ed.), Wiley Ed., ISBN-10: 1119604451, ISBN-13: 978-1119604457 3. IPCC (2021). Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge (U.K.): Cambridge Univ. Press 4. Chancel, L., Bothe, P. & Voituriez, T. (2023). Climate Inequality Report 2023, World Inequality Lab Study 2023/1 5. European Environment Agency (2023). Environmental challenges in a global context; Https://www.eea.europa.eu/soer/2010/synthesis/synthesis/chapter7.xhtml/download.pdf 6. Earth.org webpage (2023). https://earth.org/the-biggest-environmental-problems-of-our-lifetime/
Assessment	Research project