AC Angewandte Chemie

Hochschule Reutlingen
Reutlingen University

Reutlingen University
School of Applied Chemistry

Course compendium for exchange students

Summer Semester 2023

Biophysical Chemistry

Study Program Study level and semester	BWB Bachelor, 2nd semester
ECTS Credits	5 Credits
Hours per week / total contact hours	4 / 60
Total hours of study	150
Type/Teaching Method	Lecture, Exercises, Laboratory
Language of instruction	English;German
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:	Acquisition of knowledge in physical chemistry relevant to the life sciences Expertise Mastering the basic skills in Physical Chemistry for the fields of thermodynamic, chemical thermodynamic, phase equilibria, chemical and biological kinetics, mass transport Structure and dynamics of biomolecules Skills Understanding physico-chemical principles and methods Understanding the relationship of chemical structures to the macroscopic properties of the substances Acquisition of experimental skills for physical chemical measurement techniques and evaluation methods • Applications of scientific working methods in physical chemistry • Ability for independent scientific work and experimentation Social skills: Promoting teamwork in exercises and internships
Contents:	Lectures 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 2h

Macromolecular Chemistry 1

Study Program **Study level and semester**	ACB;BWB Bachelor, 4th semester
ECTS Credits	4 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	120
Type/Teaching Method	Lecture
Language of instruction	English;German
Frequency	summer semester;winter semester
Course Coordinator/Instructor	Prof. Dr. Günter Lorenz Email: Guenter.Lorenz@Reutlingen-University.DE
Restrictions (if applicable)	None
Prerequisites:	Organic Chemistry
Course learning objectives:	The students shall adopt basics of organic substances in view of possible applications in engineering and science. Knowledge: Important syntheses and reaction mechanisms for the fabrication of high-molecular organic products Characterization of macromolecular substances Basic knowledge of physical, chemical, and technical aspects of the production of polymers as well as their characteristics and features The participants are able to apply experimental methods for the preparation of simple organic materials Technical skills: Participants are able to apply the learned stuff to questions of medical and pharma industry Social skills: To develop an awareness of possible impacts on the environment of their doings.
Contents:	Basic definitions in macromolecular chemistrty Reactions and polymer generating reactions

	Modification of polymers Polymeric biomaterials
Textbooks:	1. J.M.G. Cowie, Valeria Arrighi, Polymers: Chemistry & Physics of Modern Materials, 3rd ed., CRC Press 2007, ISBN 9780849398131. 2. H.G. Elias, An Introduction to Polymer Science, Wiley 1997, ISBN: 978-3-527-28790-1. 3. Seymour/Carraher´s Polymer Chemistry, Marcel Dekker, Inc., New York, Basel, 7th ed., 2008, ISBN-13: 978-1-4200-5102-5 4. Fried, Joel R.: Polymer Science and Technology, 3rd. ed., Prentice Hall, New Jersey 2014, ISBN-13: 978-0137039555.
Assessment	Graded: exam (2 hours)

Surfaces

Study Program **Study level and semester**	ACB;BWB Bachelor, 6th semester
ECTS Credits	3 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	90
Type/Teaching Method	Lecture
Language of instruction	English;German
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:	Thermodynamics of interfaces.

	• 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. Adsorption. • Thermodynamics of adsorption. Adsorption models. Measurements with adsorption isotherms. • Adsorption from gas phase. Adsorption from solutions. • Biological relevance. Protein adsorption. Lipid deposition. Surfactants • 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	Graded: Written exam (1 hour)

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	90
Type/Teaching Method	Lecture and exercises
Language of instruction	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 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 - 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	Exam (1 hour) and presentation

Project Laboratory in Chemistry & Biomedicine

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	English
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Ralf Kemkemer; Kiriaki Athanasopolu Email: Ralf.Kemkemer@Reutlingen-University.DE
Restrictions (if applicable)	Admission capacity for this course is limited to 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 (40%) and presentations, project proposal and report (60%)

Lab: Macromolecular Chemistry

Study Program Study level and semester	ACB Bachelor, 6th semester
ECTS Credits	3 Credits
Hours per week / total contact hours	4 / 60
Total hours of study	90
Type/Teaching Method	
Language of instruction	English;German
Frequency	summer semester;winter semester
Course Coordinator/Instructor	Prof. Dr. Günter Lorenz Email: Guenter.Lorenz@Reutlingen-University.DE
Restrictions (if applicable)	Only after prior arrangement
Prerequisites:	Knowledge in organic chemistry
Course learning objectives:	Promotion of manual skills in the laboratory; Proficiency in the use and correct disposal of organic-chemical hazardous substances; Enhancement of the experimental skills in macromolecular synthesis; Application of evaluation processes and principles of documentation and reporting; students are able to document and present analysis results in a scientific and structured way; Improvement of independent scientific thinking and experimenting
Contents:	Synthesis and characterisation of polymers; important procedures for production and modification of polymers; testing of polymer properties, using spectroscopy, determination of molecular weight, end groups, melting point, and solubility; documentation of the experimental results
Textbooks:	
Assessment	Entrance colloquium, test protocolls and graded exit colloquium

Human Biology 1 (cell biology)

Study Program **Study level and semester**	BWB Bachelor, 1st semester
ECTS Credits	3 Credits
Hours per week / total contact hours	2 / 30
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. Petra Groß-Kosche Email: Petra.Gross-Kosche@Reutlingen-University.DE
Restrictions (if applicable)	Best for students with sufficient German knowledge
Prerequisites:	
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)

Study Project

Study Program Study level and semester	Various Bachelor; 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	English;German
Frequency	summer semester;winter semester
Course Coordinator/Instructor	Various (topic dependent)
Restrictions (if applicable)	
Prerequisites:	
Course learning objectives:	The student can work on a small project independently.
Contents:	Each project is to be discussed on an individual basis.
Textbooks:	
Assessment	Project report

Process Engineering and Industrial (Bio)Chemistry

Study Program Study level and semester	ACM;BMS;PAT 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. Wolfgang Honnen Email: Wolfgang.Honnen@Reutlingen-University.DE
Restrictions (if applicable)	Admission capacity for this course is limited
Prerequisites:	Knowledge in physics, chemistry, mathematics
Course learning objectives:	Knowledge Knowledge of important fundamentals in chemical engineering Knowledge of the importance of mechanical and thermal unit operations Knowledge of important examples of industrial chemical and bio chemical plants Skills Ability to apply principles of fluid mechanics in calculations for technical processes Ability to understand the physical basis of chemical engineering and to govern methods based on it. Ability to understand the significance of heat and mass transfer and in nature and technology and estimate and calculate heat and mass transfer processes Technical competences Competent application of the mechanical and thermal unit operations, which are important in the assessment of devices or equipment in the process engineering industries Competence to interpret such technical systems in the students' future careers or to virtually understand, operate and master complete processes based on the acquired knowledge.

	Competence to assess critically conventional solutions, to improve or to replace them with new solutions. Social competence Ability to think conceptually Development and strengthening of team and communication skills
Contents:	1. Fundamentals of chemical engineering Mass and energy conservation Fluid mechanics (fluid statics, fluid dynamics, Bernoulli's energy equation and metering of flows with examples) Phase transitions Heat and mass transfer 2. Selection of mechanical and thermal unit operations Mixing and agitation Filtration Heat exchange, in particular heat transfer processes with phase change Distillation Adsorption Absorption Crystallization Drying 3. Selected flowsheets (examples of industrial chemical and bio-chemical plants)
Textbooks:	1. Jess, Andreas; Wasserscheid, Peter: Chemical Technology, An Integral Textbook, Wiley-VCH (2013) 2. McCabe, Warren L.; Smith, Julian C.;Harriott, Peter: Unit Operations of Chemical Engineering, International Edition, McGraw-Hill Higher Education, 7th ed. (2005) 3. Doran, Pauline M.: Bioprocess Engineering Principles, Academic Press, 2. ed. (2012) 4. Katoh, Shigeo; Horiuchi, Jun-ichi; Yoshida, Fumitake: Biochemical Engineering, A Textbook for Engineers, Chemists and Biologists, Wiley-VCH , 2nd, rev. and enl. ed. (2015)
Assessment	Graded: Written exam (2h), presentation

Materials and Applications in Biomedical Sciences

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

Environmental Chemistry

Study Program **Study level and semester**	UWS Master, 1st semester
ECTS Credits	3 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	90
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	summer semester;winter semester
Course Coordinator/Instructor	Prof. Dr. Daniela Almeida-Streitwieser Email: D.Almeida_streitwieser@Reutlingen-University.DE
Restrictions (if applicable)	German level B1
Prerequisites:	General fundamentals of chemistry
Course learning objectives:	The following knowledge, skills and competencies will be acquired: Students know and have understood the most important environmental chemistry principles and relationships, especially the chemical processes occurring in the lithosphere, hydrosphere and atmosphere that are significant for the environment. They discuss environmental chemistry topics in a team, evaluate scientific observations and create plans of action for environmental protection based on these observations.
Contents:	This course teaches essential aspects of environmental chemistry as a subdiscipline of the chemical sciences, with particular emphasis on chemical issues in the lithosphere, hydrosphere and atmosphere, as well as the significance of anthropogenic pollutant inputs.
Textbooks:	.A. Hites, J.D. Raff und P. Wiesen: Umweltchemie – eine Einführung mit ufgaben und Lösungen, Wiley-VCH, 2017
Assessment	Written exam (60 min.)

Environmental Analytics

Study Program Study level and semester	UWS Master, 1st semester
ECTS Credits	3 Credits
Hours per week / total contact hours	2 / 30
Total hours of study	90
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Daniela Almeida-Streitwieser Email: D.Almeida_streitwieser@Reutlingen-University.DE
Restrictions (if applicable)	German level B1
Prerequisites:	General fundamentals of chemistry
Course learning objectives:	The following knowledge, skills and competencies will be acquired: • Understanding environmental analytics as a tool for objective assessment of environmental quality • Understanding the legal framework of environmental analytics • Appreciation of the possibilities and limitations of environmental analytics
Contents:	• Legal framework of environmental analysis • Sampling, sample preparation • Environmental analytical methods in the compartments water, soil and air
Textbooks:	1. Schwedt, G.: Taschenatlas der Analytik, Wiley-VCH, 2007 2. Otto, M.: Analytische Chemie, Wiley-VCH Weinheim, 2011 3. Kolb, B.: Gaschromatographie in Bildern, Wiley-VCH Weinheim, 2003 4. Meyer, V. R.: Praxis der Hochleistungsflüssigchromatographie, Wiley-VCH Weinheim, 2009 5. Funk, W., Damann, V. & G. Donnevert: Qualitätssi-cherung in der analytischen Chemie, Wiley-VCH Weinheim, 2005
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)	
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 (2 hours)

Lab: Sustainable Chemistry

Study Program Study level and semester	CNB Bachelor, 3rd semester
ECTS Credits	8 Credits
Hours per week / total contact hours	
Total hours of study	
Type/Teaching Method	Laboratory
Language of instruction	German
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Günter Lorenz Email: Guenter.Lorenz@Reutlingen-University.DE
Restrictions (if applicable)	German level B2
Prerequisites:	
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

Microbiology 1+2

Study Program Study level and semester	BWB Bachelor, 3rd Semester
ECTS Credits	5 Credits
Hours per week / total contact hours	
Total hours of study	
Type/Teaching Method	Lecture
Language of instruction	German; videos and handouts in English
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Petra Groß-Kosche Email: Petra.Gross-Kosche@Reutlingen-University.DE
Restrictions (if applicable)	Best for students with sufficient German knowledge
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 interpret them
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

Cell Culture Technology 1+2

Study Program	BWB
Study level and semester	Bachelor, 4th Semester
ECTS Credits	5 Credits
Hours per week / total contact hours	
Total hours of study	
Type/Teaching Method	Lecture
Language of instruction	German; videos and handouts in English
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Petra Groß-Kosche Email: Petra.Gross-Kosche@Reutlingen-University.DE
Restrictions (if applicable)	Best for students with sufficient German knowledge
Prerequisites:	
Course learning objectives:	• Students will be able to describe and understand general cell culture handling methods. • They can explain and interpret cell-based test methods and molecular biological analyses. • Using selected examples from the literature, students apply their knowledge and learn to analyze and evaluate scientific lines of reasoning.
Contents:	Cell Culture Technology 1+2 • Introduction to cell culture technology • Theoretical basics of animal cell handling • Cell-based analytics (cell viability, cytotoxicity assays, fluorescence-based methods) • Cell nuclear architecture & gene expression • Production of mAB 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

Analytics and Quality

Study Program Study level and semester	CNB Bachelor, 2nd semester
ECTS Credits	5 Credits
Hours per week / total contact hours	2 / 60
Total hours of study	
Type/Teaching Method	Lecture
Language of instruction	German
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Daniela Almeida-Streitwieser Email: D.Almeida_streitwieser@Reutlingen-University.DE
Restrictions (if applicable)	German level B1/B2
Prerequisites:	General inorganic and analytical chemistry (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 • 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, certificationand 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

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
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev E-Mail: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	
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

Thermal Analysis and Process Safety

Study Program Study level and semester	PPM Master, 1st 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 (w/ minor parts in English)
Frequency	summer semester; winter semester
Course Coordinator/Instructor	Prof. Dr. Andreas Kandelbauer Prof. Dr. Mark Brecht fun
Restrictions (if applicable)	
Prerequisites:	
Course learning objectives:	After successful completion of this module: • Students understand principles and theory of thermal analytical methods such as Differential Scanning Calorimetry (DSC), Thermogravimetry (TGA), Dynamic Mechanical Analysis (DMA), Rheology, Reaction Calorimetry (RC) and other calorimetric methods. • Students understand the determination of basic characteristic values of material constants (melting points, glass transition temperatures, reaction enthalpies, etc.). • Students derive complex information from calorimetric and rheometric measurements (reaction kinetics, activation energy barriers, thermal stability parameters, etc.). • Students derive relevant data in the context of thermal process safety. • Students derive and predict technologically important information regarding process windows, process optimization and process safety. • Students set-up complex experiments in order to study the physical / chemical systems (guidelines for thermal and rheological analysis). • Students apply specialized data treatment methods. (3) • Students apply mathematical methods for Data treatment (kinetic modelling). • Students apply commercial software packages. • Students select appropriate thermal and rheological analysis protocols depending on the problem. • Students critically examine experimental results. • Students correctly apply thermal and rheological material data and application of these data for process understanding and optimization.

	• Students interpret such technical systems in the students' future careers or to virtually understand, operate and master complete processes based on the acquired knowledge. • Students assess critically conventional solutions to improve or to replace them with new solutions. • Students have a detailed knowledge of geometrical and ray optics • Students understand the formation of images by mirrors and lenses • Students understand the difference between geometrical and wave optics • Students are able to solve problems of intermediate complexity • Students are able to construct images formed by a simple lens system (e.g. a microscope) • Students have a profound knowledge of the most relevant microscopic techniques • Students are able to assign a problem to the most relevant microscopy techniques • Students are able to analyze a given microscopy technique and find out the most relevant relations • Students create and give an oral presentation about a microscopic technique for other students
Contents:	• Basics and application of standard and advanced thermal analytical and calorimetric methods in the laboratory • Principles and experimental set-ups of different kinds of calorimetry • Judgement of the advantages and disadvantages, application fields and limits of the various thermal analytical methods • Reaction calorimetry / microcalorimetry, Application of real-time temperature / heat-flow measurements in chemical reactions • Classic and advanced means of data treatment (e.g., model-based and model-free kinetic data analysis) • Prerequisites for obtaining good data • Derivation of quality relevant characteristic data • Use of thermal data in the risk assessment of thermally stimulated physical/chemical processes
Textbooks:	7. Ehrenstein GW, Riedel G, Trawiel, Thermal Analysis of Plastics: Theory and Practice, Hanser, 2004 8. Frick A, Stern C, DSC-Prüfung in der Anwendung, Hanser, 2013 9. Sarge SM, Höhne GWH, Hemminger W, Calorimetry. Fundamentals, Instrumentation, and Applications, Wiley, 2014 10. Stoessel F, Thermal Safety of Chemical Processes. Risk Assessment and Process Design, Wiley, 2008

	11. Vyazovkin S, Isoconversional Kinetics of Thermally Stimulated Processes, Springer, 2015 12. Wissenschaftliche Originalliteratur (Aufgaben-bezogene Artikel aus peer-reviewed Zeitschriften) 13. Brummer R, Rheology Esseentials of Cosmetic and Food Emulsions, Springer Berlin, 2005 14. Mezger Th, The Rheology Handbook, Vincentz, 2006 15. Schramm G, Einführung in die Rheologie und Rheometrie, Gebr. Haake, Karlsruhe 16. Hecht, E.: Optics, Addison-Wesley, 2001 17. Demtröder, W.: Laser spectroscopy I & II, Springer; 5th ed. 2014 18. Murphy, D.B.: Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Blackwell; 2nd ed. 2012 19. Scientific publications
Assessment	Written exam, presentation

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
Course Coordinator/Instructor	Prof. Dr. Rumen Krastev E-Mail: Rumen.Krastev@Reutlingen-University.DE
Restrictions (if applicable)	
Prerequisites:	Basic understanding (BSc-level) of chemistry, biology and biomedical technology, 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:	20. Schwedt, G.: Taschenatlas der Analytik, Wiley-VCH, 2007 21. Otto, M.: Analytische Chemie, Wiley-VCH Weinheim, 2011 22. Kolb, B.: Gaschromatographie in Bildern, Wiley-VCH Weinheim, 2003 23. Meyer, V. R.: Praxis der Hochleistungsflüssigchromatographie, Wiley-VCH Weinheim, 2009 24. Funk, W., Damann, V. & G. Donnevert: Qualitätssi-cherung in der analytischen Chemie, Wiley-VCH Weinheim, 2005
Assessment	Written exam