



Module Description

Master of Science in Biomedical Technologies

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1. Outline of the Program

The Biomedical Technologies master's program responds to the ever-growing need for qualified specialists within biomedical and technical field. The aim of the Master's course is to qualify for a research-related professional activity in this field. It has been designed to provide a broad base of knowledge and the opportunity to specialize in the field of Bioimaging, Biomedical Engineering or NanoBioAnalytics.

The Master's program in Biomedical Technology is a consecutive, research-oriented program, which leads to a Master of Science (M. Sc.) degree. It lasts two academic years and includes a total of 120 ECTS.

The two-year curriculum is divided into two main parts:

In the first year the students are concentrating on deepening knowledge and advanced laboratory research training, acquiring broad competences in the field of biomedical technologies, including specific knowledge in the fields of bioimaging, nanotechnology and biomedical engineering. Students can also choose from a wide catalog of elective modules allowing the student to tailor the program to their individual interests.

In the second year two Practical work experiences and Master Thesis Research Project form a major component of the program and entails one year of full-time practical work in the laboratory on three different research projects. In that way the graduates of the master's program train analytical thinking and judgment as well as practical research skills and knowledge.

The teaching of "soft skills" such as communication, presentation techniques and project management (e.g. module MEDTECH Innovation), which are an integral part of many modules, also plays an important role. In addition to deepening their technical and methodological skills, the students also develop their social and communication skills with Teamwork and Presentation Techniques as well as Consideration of social and ecological aspects (e.g. module Ethical and Social Aspects of Biomedical Technologies) so that they can apply different working and communication styles. In addition to the written master's thesis an oral presentation has to be completed in front of the experts, in which the graduates must represent the results of their research.

Objectives of the Program

Graduates of the Biomedical Technologies M.Sc. are qualified and well prepared for professional careers in the field of academic research or in the industry. They have comprehensive theoretical and practical expertise in different biomedical technologies and laboratory techniques and methods.

The course is to impart a profound knowledge of regulatory affairs in the field of medical devices from patenting to approval including mandatory quality control measures.

According to the chosen specializations (two out of three possible) graduates have in-depth expertise either in the field nanotechnology for medical applications including soft matter and polymer physics, mechanics of cells and tissues, physics of the cytoskeleton, cellular forces, motor proteins, methods in nanobiophysics, high resolution microscopy techniques, micro- and nano-fluidics, lab-on-a-chip technology and/or clinical and preclinical imaging including MRT, PET, CT, SPECT and optical

imaging and/or biomedical engineering including tissue engineering, biomaterials, reactor technology, operational procedures, design and use of clinical trials.

Graduates of the Master's program are able to plan and perform independent experiments to answer scientific questions ranging from molecular biology to biochemical composition of the materials. They have the expertise to analyze, interpret and statistically evaluate obtained results and to present them in front of scientific community.

Language requirements:

English is the main language of instruction and examination including master's thesis and oral presentation. The required level of English is C1. Knowledge of German is not obligatory for the degree program but will make everyday life in Tübingen and socialization easier. Few elective courses are offered in German as well.

2. Curriculum

2.1 Overview by Study Progress



2.2 Overview by Study Modules

The program for *Biomedical Technologies* consists of the following modules:

No	Module Name	ECTS
	Mandatory courses	
M1	<i>Biomedical Technologies in Diagnostic and Therapy</i>	6
M2	<i>Laboratory Techniques and Methods</i>	3
M3	<i>Regulatory Affairs of Medical Devices</i>	3
M4	<i>Clinical cases and Consequences for Medical Devices</i>	6
	Specialization areas <i>2 out of 3 of the following specialization areas each with lecture, seminar and labwork with 15 ECTS in total have to be chosen</i>	
S1	<i>Bioimaging</i>	15
S1V	<i>Bioimaging – Lecture and Seminar</i>	6
S1P	<i>Bioimaging – Labwork</i>	9
S1PWE	<i>Bioimaging – Practical work experience*</i>	15
S2	<i>NanoBioAnalytics</i>	15
S2V	<i>NanoBioAnalytics – Lecture and Seminar</i>	6
S2P	<i>NanoBioAnalytics – Labwork</i>	9
S2PWE	<i>NanoBioAnalytics – Practical work experience*</i>	15
S3	<i>Biomedical Engineering</i>	15
S3V	<i>Biomedical Engineering – Lecture and Seminar</i>	6
S3P	<i>Biomedical Engineering – Labwork</i>	9
S3PWE	<i>Biomedical Engineering – Practical work experience*</i>	15
	Elective courses <i>Modules comprising 12 ECTS in total have to be chosen</i>	
AS4.1	<i>Bioimaging – Lecture and Seminar only</i>	6
E2	<i>NanoBioAnalytics – Lecture and Seminar only</i>	6
E3	<i>Biomedical Engineering– Lecture and Seminar only</i>	6
E4ST	<i>Aktorik in der Gerätetechnik</i>	6
E6ST	<i>Interface-Design</i>	6
E7ST	<i>Grundlagen der Keramik und Verbundwerkstoffe</i>	6

E10ST	<i>Optische Systeme in der Medizintechnik</i>	6
BM8	<i>Biostatistics</i>	6
E13	<i>Ethical and Social Aspects of Biomedical Technologies</i>	3
E14	<i>MEDTEC Innovation</i>	9
E15	<i>MRI-applications for neuroscientific and clinical research</i>	6
E16	<i>Medical Technology Aspects of Cardio-Vascular Medicine</i>	3
E1	<i>NanoBioPhysics and scanning probe microscopy</i>	3
E17	<i>Biostatistics of Clinical Studies</i>	3
MT	<i>Master Thesis*</i>	30
	<i>*Can also be completed in industry or abroad and have to be performed within the selected specialization areas!</i>	

3. Module Descriptions

Number: M1	Title: <i>Biomedical Technologies in Diagnostic and Therapy</i>			Nature: compulsory
Credit points	6 CP			
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 60 h (2 SWS per semester) self-study (preparation for exams included): 120 h			
Duration	1 semester			
Time schedule	The module is offered only in the winter term.			
Language	English			
Number of participants	Minimum: 5			
Structure /Teaching methods	lecture (4 SWS)			
Contents	The course provides important and up-to-date knowledge of different biomedical technologies: Heart-lung machine, artificial respiration, anaesthetic technique, computer-assisted surgery, electromedical technique, electronic implants, rehabilitation technology, biocompatible prosthesis, biomedical laser applications			
Objectives	After completion of this module, students will be able to understand the state-of-the-art technologies, modern methodologies and open questions in selected fields of biomedical technologies. The students know a selection of relevant biomedical technologies and can analyse compare the advantages and disadvantages. The students are able to evaluate biomedical technologies and know the different requirements for the use of biomedical technologies			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Biomedical Technologies in Diagnostic and Therapy	Written examination	1-5	6 ECTS
Applicability	M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. Medizintechnik, Universität Stuttgart (elective course)			
Recommended semester	1 st Semester			
Participation requirements	B.Sc. degree			
Person responsible	Dr. Alfio Milazzo			
Literature / Teaching materials	Texts and books will be announced at the beginning of term.			

Number: M 2	Title: <i>Laboratory Techniques and Methods</i>			Nature: compulsory
Credit points	3 CP			
Work load - contact hours (SWS) - self study	Total: 90 h contact hours: 30 h (2 SWS per semester) self-study (preparation for exams included): 60 h			
Duration	1 semester			
Time schedule	The module is offered once per year in the winter term.			
Language	English			
Number of participants	Minimum: 5			
Structure /Teaching methods	lecture (2 SWS)			
Contents	The course provides important and up-to-date knowledge of different basic and state-of-the-art laboratory techniques. These techniques include general good scientific practice and statistical analysis, providing the base for every scientific work. Specific techniques covered in this program include, but are not limited to cell culture, xNA isolation, bioanalytics and separation sciences, mass spectrometry, metabolomics and standard laboratory procedures such as ELISA and Western-Blot. <u>Thematic focus:</u> - xNAs, metabolomics, bioanalytics, evaluation of biopolymers, ELISA, Western-Blot - mass spectrometry, separation science, analytical methods on implant surfaces - research methodologies, experimental design - good scientific practice, statistics and data evaluation			
Objectives	After completion of this module, students will be able to understand the theory behind the different reviewed laboratory techniques and methods. Additionally, students will be able to plan experiments to answer scientific questions (ranging from molecular biology to biochemical composition of materials) by identifying and choosing suitable analytical methods. Additionally, students will gain the expertise to analyze, interpret and statistically evaluate data and results obtained from the taught methods under good scientific practice aspects.			
Requirements for credit points/exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Laboratory Techniques and Methods	Written exam	1-5	3 ECTS
Applicability	M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. in Medizinische Strahlenwissenschaften/Medical Radiation Sciences (elective course)			
Recommended semester	1 st semester			
Participation requirements	B.Sc. degree			
person responsible	Prof. Dr. Schenke-Layland, Katja katja.schenke-layland@uni-tuebingen.de			
Literature / Teaching materials	Texts and books will be announced at the beginning of term.			

Number: M3	Title: <i>Regulatory Affairs of Medical Devices</i>			Nature compulsory
credit points	3 CP			
work load - contact hours (SWS) - self study	Total: 90 h contact hours: hybrid 30 h (2 SWS per semester) self-study (preparation for exams included): 60 h			
Duration	1 semester			
Time schedule	The module is offered only in the summer term.			
Language	English			
Number of participants	Minimum: 5			
Structure /Teaching methods	- lecture 2 SWS			
Contents	<u>Thematic focus:</u> - regulatory affairs, patents, quality control, ethical aspects, audits, startups - quality, risk and project management - incorporation of industry-based lectures The course provides important and up-to-date knowledge regarding regulatory affairs in the field of medical devices. The students will learn about the implemented mandatory safety strategies that ensure high quality materials and products in both academia and industry. These include, yet are not limited to, regulatory affairs, patenting and auditing. Additionally, measures to maintain quality will be highlighted by experts from academia and industry, including quality control and management. As universities are encouraging students to found spin-offs, students will gain insights on the objectives, hurdles and opportunities of creating their own startups from knowledgeable experts. Students will be introduced to the regulation of animal studies, design control, ATMPs and clinical evaluation, while considering ethical aspects of the development of medical devices.			
Objectives	After the course, students will be able to - classify medical devices in corresponding regulations - recapitulate requirements for medical device in order to be patented and approved - describe the life cycle of a medical device from patenting to approval including mandatory quality control measures - recapitulate methods to ensure quality in an academic and industrial context			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	Assessment consists of following parts	Grading scheme	weighting
	Regulatory Affairs of Medical Devices	Written mid-term test	1-5	1.5 ECTS (50%)
		Written final exam	1-5	1.5 ECTS (50%)

Applicability	M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. in Medizinische Strahlenwissenschaften/ Medical Radiation Sciences (elective course)
Recommended semester	2 nd semester
Participation requirements	B.Sc. degree
Person responsible	Schenke-Layland, Katja, Prof. Dr. katja.schenke-layland@uni-tuebingen.de
Literature / Teaching materials	Texts and books will be announced at the beginning of term.

Number: M4	Title: <i>Clinical Cases and Consequences for Medical Devices</i>			Nature compulsory
Credit points	6 CP			
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 60 h (4 SWS) self-study (preparation for exams included): 120 h			
Duration	1 semester			
Time schedule	The module is offered once a year starting with lecture I in the winter term.			
Language	English			
Number of participants	Minimum: 5			
Structure /Teaching methods	lecture (4 SWS)			
Contents	<u>Thematic focus:</u> The course provides up-to-date knowledge of different clinical cases (e.g., brain diseases), diagnostic and therapeutic procedures (e.g., neuromodulation), the potential, limitations and future perspectives of medical technology devices.			
Objectives	After completing the module, students will have - knowledge of the symptoms, pathophysiology, demographics and epidemiology of different clinical cases, - an understanding of different diagnostic and therapeutic procedures, - the ability to assess the potential and limitation of pharmacological and non-pharmacological interventions, - knowledge of the state-of-the-art of medical technology devices and the skill to evaluate them from a clinical perspective, - an understanding of unresolved therapeutic challenges and the ability to develop ideas and strategies to overcome them, - the ability to anticipate future trends and perspectives in medical technology.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Clinical Cases and Consequences for Medical Devices	Written exam	1-5	6 ECTS
Applicability	M.Sc. in Biomedical Technologies (mandatory course) and M.Sc. in Medizinische Strahlenwissenschaften/ Medical Radiation Sciences (elective course), M.Sc. Neuroscience, GTC (elective course), M.Sc. Cognitive Science (elective course)			
Recommended semester	2 nd semester			
Participation requirements	B.Sc. degree			
Person responsible	Gharabaghi, Alireza, Prof. Dr. med.			
Literature / Teaching materials	Texts and books will be announced at the beginning of term. There is no general script.			

Number: S1V/AS4.1.	Title: <i>Bioimaging – Lecture and Seminar</i>			Nature: specialization
Credit points	6 CP			
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 56 h self-study (preparation for exams included): 124 h			
Duration	1 semester			
Time schedule	The module is offered once a year in the first half of the winter term as block course			
Language	English			
Number of participants	Seminar: max.: 20 Lecture: max.: 40			
Structure /Teaching methods	lecture and seminar (4 SWS)			
Contents	The Bioimaging module provides students with the theoretical and methodological background of modern imaging techniques used in biomedical research and clinical diagnostics. As the course builds on biological and medical principles, participants are expected to have a basic background in biomedicine, biology, or related life sciences.			
Objectives	Throughout the module, students gain an in-depth understanding of advanced imaging technologies, including MRI, PET/MRI, PET/CT, and optical imaging, as well as specialized techniques such as functional MRI (fMRI), hyperpolarized MRI, MR angiography, and integrated PET/MR imaging. Additional topics include image reconstruction and correction, radiochemistry, tracer development, and pharmacological modelling. Students also acquire knowledge of the use and application of radioactive tracers and the fundamental principles of radiation protection. Practical components are conducted in part using small animal models, providing insight into the design and implementation of imaging experiments in neurological, oncological, immunological, and metabolic research. In addition, students become familiar with commonly used software tools for the analysis of clinical and preclinical imaging data.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	Assessment Consists of two parts	Grading scheme	weighting
	Lecture/Seminar	Written/oral examination & Written Lab book	1-5 1-5 (rating according to the fulfillment of the general Lab book guidelines of the UKT)	2/3 1/3
Applicability	M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/ Medical Radiation Sciences (elective course) and elective course for students of M.Sc. Medical Engineering Univ. of Stuttgart), takes place together with AS4.1. The module Completion is required for a module S1PWE			

Recommended semester	1 st semester
Participation requirements	B.Sc. degree
Person responsible	Calaminus, Carsten, Dr. rer. nat. Carsten.calaminus@med.uni-tuebingen.de
Literature / Teaching materials	Texts and books will be announced at the beginning of term.

Number: S1P	Title: <i>Bioimaging – Labwork</i>			Nature: specialization
Credit points	9 CP			
Work load - contact hours (SWS) - self study	Total: 270 h contact hours: 90 h self-study (preparation for exams included): 180 h			
Duration	1 Semester			
Time schedule	The module is offered once a year in the winter term as block course.			
Language	English			
Number of participants	Maximum: 16 Minimum: 3			
Structure /Teaching methods	Practical Training and Seminar (6 SWS)			
Contents	<u>Thematic focus:</u> - Clinical application of PET and MRI, PET/MR application, imaging of special diseases - Clinical application of CT and US, deeper insight into clinical topics - Physics and technologies used in the nuclear medicine - Image acquisition methods in preclinical imaging (MRI, OI, PET, SPECT/CT): design for special experiments in clinic and preclinical setup and scanning of rodents - Clinical and Preclinical Application and Drawbacks of different MRI sequences - Research in Radiochemistry - Advanced Tracer development and production			
Objectives	After attending this module, students: - gain the knowledge how to prepare patients and animals for the measurements and, depending on the desired outcome, to pay attention to the special requirements of the respective scan parameters. - were part of practical demonstrations in preclinical imaging including some small hands-on experiences. - learn animal handling procedures in preclinical imaging according to the animal welfare act and §30 LHG. All animal experiments are approved by the ethical committee and the local authorities in Tübingen. - gain practical competences in detector physics - are able to analyze images in clinical and preclinical studies.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Labwork	Portfolio consisting out of 6 Protocols, evaluated equally	1-5	9 ECTS
Applicability	M.Sc. in Biomedical Technologies (specialization course), takes place together with AS4.1. The module Completion is required for a module S1PWE			
Recommended semester	1 st semester			

Participation requirements	B.Sc. degree and successful completion of module AS4.1
Person responsible	Calaminus, Carsten, Dr. rer. nat. Carsten.calaminus@med.uni-tuebingen.de
Literature / Teaching materials	Texts and books will be announced at the beginning of term.

Number: S1PWE	Title: <i>Bioimaging – Practical work experience</i>			Nature: specialization
Credit points	15 CP			
Work load - contact hours (SWS) - self study	Total: 450 h = 15 ECTS			
Duration	1 semester, min. 6 weeks and max. 6 months			
Time schedule	The module is offered once a year in the winter term as block course			
Language	English			
Number of participants	Maximum: 16 Minimum: 1			
Structure /teaching methods	Practical Training			
Contents	The Labwork contains a special topic which the student has to work on in theory and practice under the supervision of a scientist or medical doctor.			
Objectives	After the Labwork, the students are able to: - develop their research skills to an independent level. - read and understand publications about the scientific background of the project. - write an electronic lab book. - work on their own under the supervision of the scientist/medical doctor in charge. - plan and perform their own first bioimaging experiments without supervision - finish their project, write a protocol as well as to give a talk about the performed work in front of a scientific community.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Practical Training	Written report about the internship (10-15 pages, Arial 12, single-spaced)	1-5	15 ECTS
Applicability	M.Sc. in Biomedical Technologies (specialization course), recommended for master's thesis in bioimaging			
Recommended semester	3rd semester			
Participation requirements	B.Sc. degree, passed semester 1 and 2, and successful completion of modules S1V and S1P			
Person responsible	Calaminus, Carsten, Dr. rer. nat. Carsten.calaminus@med.uni-tuebingen.de			
Literature / Teaching materials				

Number: S2V or E2	Title: <i>NanoBioAnalytics – Lecture and Seminar</i>	Nature: specialization
Credit points	6 CP	
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 60 h self-study (preparation for exams included): 120 h	
Duration	1 semester	
Time schedule	The module is offered twice a year in winter and summer term	
Language	English	
Number of participants	Lecture: Maximum: 24; Minimum: 3 Seminar: Minimum: 3	
Structure /teaching methods	NanoBioAnalytics Lecture (2 SWS) and NanoBioAnalytics Seminar (2 SWS)	
Contents	<u>Thematic focus:</u> - Introduction to nanophysics, fundamentals of nanotechnology, statistical physics, transport phenomena at the micro- and nanometer scale, micro- and nanofluidics, lab-on-a-chip technology, soft matter and polymer physics, interface and membrane physics, mechanics of cells and tissues, physics of the cytoskeleton, cellular forces, motor proteins, methods in nanobiophysics, high resolution microscopy techniques, artificial intelligence in biophysical analysis - Discussion of current research topics in the field of nanotechnology and nanoanalytics for medical applications - Student prepare and present seminar talks with 30 minutes duration about selected topic and discuss them afterwards	
Objectives	The module conveys the basics and in-depth knowledge of nanoanalytics and biophysics. After attending the module, students - understand the basic phenomena, terms and concepts of nanoanalytics and biophysics - gain intuitive understanding of various physical quantities at the micro- and nanometre scale and their relevant units and magnitudes - can solve simple problems in the field of nanoanalytics and biophysics - understand the connections between the various aspects of nanoanalytics and biophysics - have the knowledge to critically discuss current fields of biomedical research - can compare and evaluate different nanoanalytical tools for different applications and sample types - learn to evaluate the quality of scientific studies and their presentation - have the competence to independently study a scientific research topic and present it in the form of an oral seminar talk - have the competence to abstract and simplify complicated scientific studies and concepts to a multidisciplinary audience - have the competence to critically read, review, and discuss scientific studies and results - have the competence to plan and schedule the preparation of their presentation	

	- have learned different formally correct citation styles in scientific presentations - are able to communicate in an understandable way about the above-mentioned technical content - have experience with testing different styles, techniques, and media for oral presentations - have gained experience in solving technical problems for giving oral presentations			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	NanoBioAnalytics Lecture	Written Examination	1-5	50%
	NanoBioAnalytics Seminar	Oral presentation (30 min presentation + 15 min discussion)	1-5	50%
Applicability	M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/ Medical Radiation Sciences (elective course) and elective course for students of M.Sc. Medical Engineering Univ. of Stuttgart			
Recommended semester	1 st or 2 nd semester			
Participation requirements	B.Sc. degree			
Person responsible	Schäffer, Tilman, Prof., Dr. rer. nat.			
Teaching staff	Rheinlaender, Johannes, PD, Dr. rer. nat.			
Literature / Teaching materials	Literature will be announced at the beginning of term.			

Number: S2P	Title: <i>NanoBioAnalytics I – Labwork</i>			Nature: specialization
Credit points	9 CP			
Work load - contact hours (SWS) - self study	Total: 270 h contact hours: 90 h self-study (preparation for exams included): 180 h			
Duration	1 semester			
Time schedule	The module is offered twice a year in winter and summer term			
Language	English			
Number of participants	Maximum: 8 Minimum: 3			
Structure /Teaching methods	Practical Training (6 SWS)			
Contents	<u>Thematic focus:</u> Planning, execution, analysis and discussion of practical experiments: - optical lithography - light microscopy - electron microscopy - scanning probe microscopy - scattering techniques - protein crystallization - mechanical material testing			
Objectives	The module conveys basic experimental techniques in nanoanalytics and biophysics. After attending the module, students - are familiar with practical work with selected experimental methods in nanoanalytics / interfaces - can test and reflect on their skills in self-conducted experiments - understand the basic phenomena, terms and concepts of the above-mentioned topics and are familiar with relevant experiments - know about the advantages and disadvantages as well as the limits of the self-conducted experiments - have competences in acquiring and analyzing empirical scientific data - train scientific writing by drafting, writing, and revising short reports			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Practical Training	Portfolio of 4 written protocols of self-conducted experiments, incl. introduction, basics, results, discussion, error analysis.	1-5	9 ECTS
Applicability	M.Sc. in Biomedical Technologies (specialization course), required for module S2PWE			
Recommended semester	1 st semester			

Participation requirements	B.Sc. degree
Person responsible	Schäffer, Tilman, Prof., Dr. rer. nat.
Teaching staff	Fleischer, Monika, Prof., Dr. rer. nat. Meyer, Jannik, Prof. Dr. rer. nat. Rheinlaender, Johannes, PD, Dr. rer. nat. Schäffer, Tilman, Prof., Dr. rer. nat. Schreiber, Frank, Prof., Dr. rer. nat.
Literature / Teaching materials	Literature will be announced at the beginning of term.

Number: S2PWE	Title: <i>NanoBioAnalytics – Practical work experience</i>			nature: specialization
Credit points	15 CP			
Work load - contact hours (SWS) - self study	Total: 450 h contact hours: 300 h self-study (preparation for exams included): 150 h			
Duration of the module	1 semester, min. 6 weeks full-time and max. 6 months			
Time schedule	Every semester			
Language	English			
Number of participants	Maximum: 8 Minimum: 1			
Structure /Teaching methods	Practical Training			
Contents	The Labwork contains a special topic that the student has to work on in theory and practice under the supervision of a scientist or medical doctor.			
Objectives	Independent practical familiarization with experimental methods in the planned area of the Master's thesis. After attending the module, students - are familiar with independent practical work with selected experimental methods in nanoanalytics / interfaces - can test and reflect on their skills in self-conducted experiments - understand the basic phenomena, terms and concepts of the special topic and are familiar with relevant experimental methods and approaches - know the current state of research and can question it critically - understand the connections between the various aspects of the special topic - know the theoretical explanatory approaches of the special topic and can apply them to different practical problems - know about the advantages and disadvantages as well as the limits of the self-conducted experiments - have competences in acquiring and analyzing empirical scientific data - have experience in drawing up a written report			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Practical Training	Written report about the internship (10-15 pages, Arial 12, single-spaced)	1-5	15 ECTS
Applicability	M.Sc. in Biomedical Technologies (specialization course),			
Recommended semester	3rd semester			
Participation requirements	B.Sc. degree and successful completion of modules S2V and S2P			

Person responsible	Schäffer, Tilman, Prof., Dr. rer. nat.
Teaching staff	Rheinlaender, Johannes, PD, Dr. rer. nat. Schäffer, Tilman, Prof., Dr. rer. nat.
Literature / Teaching materials	Literature will be announced at the beginning of term.

Number: S3V	Title: <i>Biomedical Engineering (Bioengineering) – Lecture and Seminar</i>			Nature: specialization
Credit points	6 CP			
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 60 h self-study (preparation for exams included): 120 h			
Duration	1 semester			
Time schedule	The module is offered once per year in the summer term as block course			
Language	English			
Number of participants	Lecture: max.: 50 Seminar: max.: 24			
Structure /teaching methods	lectures and seminars (4 SWS)			
Contents	<u>Thematic focus:</u> - General Tissue Engineering: Cell biology, Biomaterials and Scaffolds, cell-/material interface, host response, - Bioengineered in vitro Models: Spheroids, transwell models, organoids, microfabrication and organ-on-chip - Therapeutic approaches: ATMPs, Gene Therapies, Neuroimplants			
Objectives	Students - Get fundamental overview over tissue engineering approaches, concepts and applications. - Gain knowledge about different types of bioengineered in vitro models from the development to regulatory aspects, with their advantages, limitations, and applications - Gain insight in state-of-the-art technologies and basics of microfabrication and biomaterial research - Learn how bioengineered technologies enable novel types of therapeutic approaches. - Understand the coupling and interaction between technical implants and tissues and gain knowledge about the functionalisation of surfaces			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Lecture	Written/oral exam	1-5	50%
	Seminar	Oral presentation (30 min presentation + 15 min discussion)	1-5	50%
Applicability	M.Sc. in Biomedical Technologies (specialization and elective course) and M.Sc. in Medizinische Strahlenwissenschaften/ Medical Radiation Sciences (elective course) and elective course for students of M.Sc.			

	Medical Engineering Univ. of Stuttgart), required for modules S3V and S3PWE
Recommended semester	2 nd semester
Participation requirements	Successful completion of a Bachelor degree in Medical Technologies, or equivalent
Person responsible	Loskill, Peter, Prof., Dr. rer. nat. Peter.Loskill@uni-tuebingen.de
Literature / Teaching materials	Texts and books will be announced at the beginning of term.

Number: S3V	Title: <i>Biomedical Engineering (Bioengineering) – Labwork</i>			Nature: specialization
Credit points	9 CP			
Work load - contact hours (SWS) - self study	Total: 270 h contact hours: 90 h self-study (preparation for exams included): 180 h			
Duration	1 semester			
Time schedule	The module is offered once per year in the summer term			
Language	English			
Number of participants	Maximum: 16 Minimum: 3			
Structure /teaching methods	Practical Training			
Contents	<u>Thematic focus:</u> - Tissue engineering: cell biology, biomaterials, extracellular matrix (ECM), micropatterning - Implants: ATMPs, cell-/material interface, host response, biostability, biocompatibility - Bioengineered in vitro models: Spheroid, transwell models, organ-on-chip			
Objectives	Students • Get hands-on experience in tissue engineering including cell and tissue culture techniques, properties of biomaterials, cell and tissue analysis, organoid and organ-on-chip technology • Gain expertise in design and use of implants (e.g. hearing implants, visual implants,) and characterization of implant surfaces • Learn how to document properly and create reports			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Practical Training	Portfolio of 4 Experimental protocols	1-5	9 ECTS
Applicability	M.Sc. in Biomedical Technologies (specialization course), required for module S3PWE			
Recommended semester	2 nd semester			
Participation requirements	Successful completion of a Bachelor degree in medical technologies, or equivalent. Passing of exam of “Biomedical Engineering – Lecture”			
Person responsible	Loskill, Peter, Prof., Dr. rer. nat. Peter.Loskill@uni-tuebingen.de			
Literature / Teaching materials	Texts and books will be announced at the beginning of term			

Number: S3PWE	Title: <i>Biomedical Engineering (Bioengineering) – Practical work experience</i>			Nature: specialization
Credit points	15 CP			
Work load - contact hours (SWS) - self study	Total: 450 h			
Duration	1 semester, min. 6 weeks full-time and max. 6 months			
Time schedule	The module is offered once per year in the summer and winter term as block course			
Language	English			
Number of participants	Maximum: 16 Minimum: 1			
Structure/Teaching methods	Practical Training (10 SWS)			
Contents	<u>Thematic focus:</u> - Tissue engineering: cell biology, biomaterials, extracellular matrix (ECM), micropatterning - Implants: ATMPs, cell-/material interface, host response, biostability, biocompatibility - Bioengineered in vitro models: Spheroid, transwell models, hydrogels and bioprinting, organoids, organ-on-chip and multi-organ-chips			
Objectives	Students have comprehensive experience with state-of-the-art research covering at least one of the thematic foci of the Biomedical Engineering specialization module. This includes in-depth literature proficiency, theoretical and conceptual knowledge as well as hands-on experience. They have expertise in reading and composing protocols, writing a laboratory notebook and scientific reporting.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	Assessment	Grading scheme	weighting
	Practical Training	Written report about the internship (10-15 pages, Arial 12, single-spaced)	1-5	15 ECTS
Applicability	M.Sc. in Biomedical Technologies (specialization course), recommended for master's thesis in biomedical engineering.			
Recommended semester	3rd semester			
Participation requirements	Successful completion of a Bachelor degree in medical technologies, or equivalent, two passed specialization blocks and successful completion of module S3V and S3P			
Person responsible	Loskill, Peter, Prof., Dr. rer. nat. Peter.Loskill@uni-tuebingen.de			
Literature/Teaching materials	Texts and books will be announced at the beginning of term			

module number: E4ST	title of the module: <i>Aktorik in der Gerätetechnik; Konstruktion, Berechnung und Anwendung mechatronischer Komponenten</i>			nature of the module: elective course
credit points	6 CP			
work load - contact hours (SWS) - self study	Total: 180 h contact hours: 42 h self study (preparation for exams included): 138 h			
duration of the module	2nd semester			
time schedule (winter/summer term)	The module is offered each semester			
language (English/German)	German			
maximum/minimum number of participants	Maximum: 20			
module structure /teaching methods	Lecture, practical training,			
contents	Behandelt werden feinwerktechnische Antriebe unterschiedlicher Wirkprinzipie mit den Schwerpunkten: - Magnettechnik/-technologie (Werkstoffe, Verfahren, konstruktive Auslegung, Magnetisierung) - Elektromagnetische Antriebe (rotatorische und lineare Schrittmotoren; Berechnung, Gestaltung, Anwendung) - Elektrodynamische Antriebe (rotatorische und lineare Gleichstrom-kleinstmotoren; Berechnung, Gestaltung, Anwendung) - Piezoelektrische, magnetostriktive und andere unkonventionelle Aktorik (neue Werkstoffe in mechatronischen Komponenten, Berechnung, Gestaltung, Anwendung) - Beispiele zur Realisierung mechatronischer Lösungen in der Gerätetechnik. Beispielhafte Vertiefung in zugehörigen Übungen und Praktika (Spezialisierungsfachpraktika und APMB).			
objectives	Die Studierenden kennen die Grundlagen der Magnettechnik und -technologie (Werkstoffe, Verfahren, konstruktive Auslegung, Magnetisierung). Die Studierenden können elektromagnetische Antriebe (rotatorische und lineare Schrittmotoren) vereinfacht berechnen, gestalten und auslegen. Die Studierenden können elektrodynamische Antriebe (rotatorische und lineare Gleichstromkleinstmotoren) vereinfacht berechnen, gestalten und auslegen. Die Studierenden kennen piezoelektrische, magnetostriktive und andere unkonventionelle Aktorik.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Oral exam (ca. 40 min)	1-5	6 ECTS
applicability	M.Sc. in Biomedical Technologies (elective course)			
recommended semester	1 st or 2nd semester			
participation requirements	B.Sc. degree in Medical Technologies			

person responsible for the module	Schinköthe, Wolfgang, Prof., Dr.-Ing.
literature / teaching materials	Literature will be distributed before start of lecture.

Number: E6ST	Title: <i>Interface-Design</i>			Nature: elective course
Credit points	6 CP			
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 42 h self-study (preparation for exams included): 138 h			
Duration	1 semester			
Time schedule	The module is offered in the summer term only			
Language	German			
Number of participants	Maximum: 20			
Structure /teaching methods	Lecture, practical training, seminar			
Contents	Darstellung des interdisziplinären Interface-Design als Vertiefung zum Technischen Design mit Fokussierung auf alle relevanten Mensch-Maschine- Interaktionen. Beschreibung aller notwendigen Begriffe und Grundlagen zur Interfacegestaltung. Ausführliche Vorstellung der Methoden zur Integration der Makro-, Mikro- und Informationsergonomie in den gegenwärtigen Entwicklungsprozess. Darauf aufbauend werden Werkzeuge, wie Usability-Tests und Workflow-Analyse, intensiv beschrieben und deren Bewertungen und Ergebnisse diskutiert. Es werden zahlreiche realisierte Beispiele aus der Praxis als Fallbeispiele vorgestellt und behandelt.			
Objectives	Das Modul vermittelt Grundlagen und Vertiefungen zum Interfacedesign. Studierende besitzen nach dem Besuch des Moduls - das Wissen über die wesentlichen Grundlagen des Interfacedesigns als Bestandteil der methodischen Entwicklung und zur Vertiefung des Technischen Designs, - die Kenntnis über wesentliche Interaktionsprinzipien zur Wahrnehmung, Kognition und Betätigung und Benutzung, - die Fähigkeit wichtige Methoden zur Gestaltung der Mensch-Maschine-Schnittstelle anzuwenden, Lösungen zu realisieren und zu präsentieren, - die Fertigkeiten zur Planung und Durchführung von Usability-Tests mit Probanden, - grundlegende Kenntnisse zu Kriterien und Bewertung von Anzeigern und Stellteilen über die X Kompatibilitäten, - ein detailliertes Verständnis von Makro- und Mikro-Informationsergonomie und deren Integration in die Planungs-, Konzept-, Entwurfs- und Ausarbeitungsphase, - die Fähigkeit zur Durchführung und Auswertung einer Workflow-Analyse als Querschnittsfunktion, - die Fähigkeit effiziente Bedienstrategien zu beurteilen, - das Wissen über Auswirkungen und zukünftige Trends der Interfacegestaltung.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Lecture	Written exam (ca. 120 min)	1-5	6 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			

Recommended semester	1 st or 2nd semester
Participation requirements	B.Sc. degree in Medical Technologies
Person responsible	Maier, Thomas, Univ.-Prof., Dr.-Ing.
Teaching staff	Maier, Thomas, Univ.-Prof., Dr.-Ing. Schmid, Peter, M. Sc.
Literature / Teaching materials	Literature will be distributed before start of lecture.

Number: E7ST	Title: <i>Grundlagen der Keramik und Verbundwerkstoffe</i>	Nature: elective course
Credit points	6 CP	
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 42 h self-study (preparation for exams included): 138 h	
Duration	2 semesters	
Time schedule	The module is offered once per year	
Language	German	
Number of participants	Maximum: 20	
Structure /teaching methods	Lecture	
Contents	Dieses Modul hat die werkstoff- und fertigungstechnischen Grundlagen keramischer Materialien zum Inhalt. Darüber hinaus werden konstruktive Konzepte und die werkstoffspezifische Bruchmechanik berücksichtigt. Es werden keramische Materialien und deren Eigenschaften erläutert. Keramische werden gegen metallische Werkstoffe abgegrenzt. Anhand von ingenieurstechnischen Beispielen aus der industriellen Praxis werden die Einsatzgebiete und -grenzen von keramischen Werkstoffen aufgezeigt. Den Schwerpunkt bilden die Formgebungsverfahren von Massivkeramiken. Die theoretischen Inhalte werden durch Praktika vertieft und verdeutlicht. Stichpunkte: - Grundlagen von Festkörpern im Allgemeinen und der Keramik. - Einteilung der Keramik nach anwendungstechnischen und stofflichen Kriterien, Trennung in Oxid-/ Nichtoxidkeramiken und Struktur-/ Funktionskeramiken. - Abgrenzung Keramik zu Metallen. - Grundregeln der Strukturmechanik, Bauteilgestaltung und Bauteilprüfung. - Klassische Herstellungsverfahren vom Rohstoff bis zum keramischen Endprodukt. - Formgebungsverfahren, wie das Axialpressen, Heißpressen, Kalt-, Heißisostatpressen, Schlicker-, Spritz-, Foliengießen und Extrudieren keramischer Massen. - Füge- und Verbindungstechnik. - Sintertheorie und Ofentechnik. - Industrielle Anwendungen (Überblick und Fallbeispiele).	
Objectives	Die Studenten können: - Merkmale und Eigenheiten keramischer Werkstoffe unterscheiden, beschreiben und beurteilen. - Belastungsfälle und Versagensmechanismen verstehen und analysieren. - werkstoffspezifische Unterschiede zwischen metallischen und keramischen Werkstoffen wiedergeben und erklären. - Technologien zur Verstärkung von Werkstoffen sowie die wirkenden Mechanismen benennen, vergleichen und erklären. - Verfahren und Prozesse zur Herstellung von massivkeramischen Werkstoffen benennen, erklären, bewerten, gegenüberstellen, auswählen und anwenden.	

	- Herstellungsprozesse hinsichtlich der technischen und wirtschaftlichen Herausforderungen bewerten und anwendungsbezogen auswählen. - in Produktentwicklung und Konstruktion geeignete Verfahren und Stoffsysteme identifizieren, planen und auswählen. - Werkstoff- und Bauteilcharakterisierung erklären, bewerten, planen und anwenden.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam (ca. 120 min)	1-5	6 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	1 st or 2nd semester			
Participation requirements	B.Sc. degree in Medical Technologies			
Person responsible	Kern, Frank, apl. Prof., Dr. rer. nat.			
Teaching staff	Kern, Frank, apl. Prof., Dr. rer. nat.			
Literature / Teaching materials	Literature will be distributed before start of lecture.			

Number: E10ST	Title: <i>Optische Systeme in der Medizintechnik</i>			Nature: Elective course
Credit points	6 CP			
Work load - contact hours (SWS) - self study	Total: 180h contact hours: 42h self-study (preparation for exams included): 138h			
Duration	1 semester			
Time schedule	The module is offered only in the summer term			
Language	German			
Number of participants	Maximum: 20			
Structure /Teaching methods	Lecture, practical training			
Contents	Basic optical system design and optical system parameters. Basic architecture of optical systems used in medicine (microscope, surgical microscope, endoscope, ophthalmic systems) Modern microscopy methods (structured illumination, confocal, fluorescence). Optics of the human eye and ophthalmic systems. Lasers in medical diagnostics and therapy. Spectroscopic and hyperspectral methods and systems. 3-D optical metrology. Basic properties of detectors.			
Objectives	The students know how to calculate basic optical quantities within simple optical systems The students are familiar with - the optical setup of microscopes, endoscopes, and ophthalmic systems - spectral systems and their application - the properties of the human eye - properties of laser beams - polarization The students have an overview - over state-of-the-art microscopic methods in order to enhance resolution and/or contrast - laser systems and their application in medicine - important properties of optical detectors			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Lecture	Written exam	1-5	6 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	1 st or 2nd semester			
Participation requirements	B.Sc. degree in Medical Technologies			
Person responsible	Herkommer, Alois, Univ.-Prof., Dr.			
Literature /Teaching materials	Literature will be distributed before start of lecture. Additional recommended books: - Gross H.: Handbook of optical systems Vol. 1-4 - Hecht, E.: Optik (Optics) - Kühlke D.: Optik			

Number: BM8	Title: <i>Biostatistics</i>	Nature: Elective course
Credit points	6 CP	
Work load - contact hours (SWS) - self study	Total: 180 h contact hours: 90 h self-study (preparation for exams included): 90hours	
Duration	1 Semester	
Time schedule	Annual	
Language	English	
Number of participants	Lecture: no limit Tutorial: max. 28 participants	
Structure/ Teaching methods	Statistics 1: Lecture 1 (2 SWS), Tutorial (1 SWS) (elective, English) 3 ECTS Anova: Lecture 1 (2 SWS), Tutorial (1 SWS) (elective, English) 3 ECTS	
Contents	Statistics 1: Course theoretical and practical with emphasis on introduction to probability theory and inferential statistics as an essential component to solving research questions. 1. Introduction to Probability Theory. 2. Descriptive Methods. 3. Principles of Statistical Testing. 4. Examples of Statistical Tests: - One sample t-test - Independent and dependent Student test, - Mann Whitney U test and Wilcoxon Test - McNemar Test / Chi Square test - Kruskal Wallis test / Friedman Test 5. Regression and Correlation. 6. Software tutorial in R Anova: course theoretical and practical, focusing to understand the principles of analysis of variance and mixed models to analyze data from experiment 1. One-way analysis of variance 2. Post hoc comparisons 3. Two-way analysis of variance 4. Two-way analysis of variance with interaction 5. Analysis of Covariance 6. Analysis of Repeated measurements 7. Analysis of time*treatment interaction 8. Analysis of variance for non-normally distributed data 9. Mixed models 10. Sample size estimation 11. R Software tutorial	
Objectives	The students can develop statistical modelling and analysis of experiments, interventional and observational clinical studies and of epidemiological studies. They can interpret the results. The students have knowledge of statistical analysis (descriptive, confirmatory, regression, multivariate) and they can decide which method is the most adequate in a specific study. *Practical software tutorials in R are directly integrated into both the <i>Statistics 1</i> and <i>ANOVA</i> modules to translate theoretical concepts into real-world data analysis skills. Regular attendance at these tutorials is obligatory to build essential programming and statistical computing skills.	

Requirements for credit points / exams and grading scheme (where appropriate, weighting)	Course	Assessment	Grading Scheme	Weighting
	Statistics 1	Written exam and 80% attendance (R course*)	1-5	3 ECTS
	Analysis of Variance	80% attendance of tutorial		3 ECTS
Applicability	M.Sc Biomedical Technology and M.Sc Medizinische Strahlenwissenschaften			
Recommended semester	1st / 2nd Semester			
Participation requirements	The knowledge of the Course Statistics 1 is required to attend the ANOVA			
Person responsible	Martus, Peter, Prof. Dr. rer. nat. and Serna Higueta, Lina Maria PhD Peter.martus@med.uni-tuebingen.de			
Literature/ Teaching materials	To be announced at the beginning of the term			

Number: E13	Title: <i>Ethical and Social Aspects of Biomedical Technologies</i>			Nature: Elective course
Credit points	3 CP			
Work load - contact hours (SWS) - self study	Total: 90 h contact hours: 30 h self-study (preparation for exams included): 60 h			
Duration	1 semester			
Time schedule	The module is offered once per year in the summer term			
Language	English			
Number of participants	Maximum: 20 Minimum: 6			
Structure /Teaching methods	Seminar (2 SWS)			
Contents	Basics: - What makes and innovation a good innovation? - What are ethical and social aspects of biomedical technologies? - How to deal with those aspects? Joint case study of a particular biomedical technology: - What is the case? - How can we detect ethical and social aspects of the case? - How to deal with those aspects? Individual case studies of the technologies the students develop in their master thesis: - Which ethical and social aspects has my own work? - How can I deal with them?			
Objectives	- The students reflect their criteria for good innovations and get to know the debates about responsible, sustainable innovation. - The students get an idea of what ethical and social questions are. They become familiar with ethical and social scientific research on biomedical technologies. - The students are empowered to detect and to discuss ethical and social aspects of the technologies they develop. They get to know tools which support ethical and social reflections.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Seminar	Presentation during Seminar and writing of a reflection paper	1-5	3 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	1st semester			

Participation requirements	B.Sc. degree
Person responsible	Dr. Mone Spindler, IZEW
Teaching staff	
Literature/Teaching materials	Literature will be announced at the beginning of term.

Number: E14	Title: <i>MEDTEC Innovation</i>			Nature: Elective course
Credit points	9 CP			
Work load - contact hours (SWS) - self study	Total: 180 h Contact hours: 60 h Self-study: 120h			
Duration	2 semester			
Time schedule	The module is offered once per year in the winter and summer term			
Language	English			
Number of participants	Maximum: 12			
Structure /teaching methods	Lecture / Seminar combination (2 SWS)			
Contents	<u>Thematic focus:</u> - The module deals with the development process of a medical device from the industry perspective. The students will be undergoing an innovation process from primary identification of clinical unmet needs to concept generation to a functional demonstrator. During this process several steps such as self-assessment, needs finding, idea generation, IP and market analysis, as well as the physical process of drafting a design and building a demonstrator will be included.			
Objectives	Students - Are familiar with the field of innovation management - have fundamental knowledge about the importance of a structured process, challenging situations during the process and the application of ancillary tools - have expertise in important methods and processes along the definition of a project towards feasibility and fabrication of a demonstrator.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Lecture / Seminar	Presentation Concept and Demonstrator	1-5	3 ECTS (WS) 6 ECTS (SS)
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	1 st and 2 nd semester			
Participation requirements	B.Sc. degree			
Person responsible	Wahl, Siegfried, Prof. Dr. rer. nat.			
Literature/Teaching materials	Literature will be announced at the beginning of term.			

Number: BM21	Title: <i>MRI-applications for neuroscientific and clinical research</i>			Nature: Elective course
Creditpoints	6 CP			
Work load - contact hours (SWS) - self study	Total: 90h Contact hours: 30 h Self-study: 60h			
Duration	1 semester			
Time schedule	The module is offered only in summer term: Not possible to combine with Bioengineering			
Language	English			
Number of participants	Maximum: 12			
Structure/Teaching methods	Lecture and seminar			
Contents	MRI has widely increased our knowledge about the structure and function of the human brain. The continuous development of new technologies and methods in this field allow investigations to be carried out at an ever-increasing level of detail. In this course, established and emerging methods that allow robust and reproducible quantification of physiologic and pathologic processes will be taught. Topics include: - Non-invasive imaging of tissue - MR principles - Tissue structure and MRI of gray matter regions - White matter (WM) microstructure and diffusion weighting (DWI) - Mapping long-range connections, brain plasticity and neurodegeneration using DWI - MRI of WM using non-diffusion techniques - Mapping brain function, structure: connectome networks and radiomics - How structure and function modify local magnetic susceptibility - Contrast agents for cell-labelling and studies of the 'glymphatic' system - Neurochemistry and multi-nuclear magnetic resonance spectroscopy - MRI at high magnetic field strengths – Visit of the MRZ			
Objectives	After completion of the module students know how does connectivity analyses relate to the progression of neurodegenerative diseases. They are able to investigate the anatomical microstructure. Students can measure the function of the blood-brain-barrier. Students follow the fate of stem-cells within the anatomical microstructure by MR.			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	Lecture / Seminar	assessment	Grading scheme	weighting
	M.Sc. in Biomedical Technologies (elective course)	Final report 8-15 pages	Passed/failed	6 ECTS
Recommended semester	2 nd semester			
Participation requirements	B.Sc. degree			
Person responsible	Dr. Gisela Hagberg gisela.hagberg@tuebingen.mpg.de gisela.hagberg@med.uni-tuebingen.de			

Literature/Teaching materials	Literature will be announced at the beginning of term.
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Number: E16	Titel: <i>Medical Technology Aspects of Cardio-Vascular Medicine</i>			Nature: Elective course
Credit points	3 CP			
Work load - contact hours (SWS) - self study	Total: 90 h contact hours: 20 h self-study (preparation for exams included): 70 h			
Duration	1 semester			
Time schedule	The module is offered 1 per year in the winter term			
Language	English			
Number of participants	Maximum: 12 Minimum: 7			
Structure/Teaching methods	Hands-On Seminar			
Contents	- Heart: Basics of Anatomy - Heart Disease - Heart Failure - Technical Products: Cardiac Implants, Cannulas, etc. - Technical challenges and solutions			
Objectives	- The students can explain and describe the basic anatomy, physiology and pathology of a heart - The students know a selection of relevant medical technology products and can compare the advantages and disadvantages. - The students are able to evaluate the medical technology products. - The students know the different requirements for the use of medical technology products			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	exam	Grading scheme	weighting
	Seminar	Written examination	1-5	3 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	1 st semester			
Participation requirements	B.Sc. degree			
Person responsible	Prof. Dr. Tobias Walker			
Teaching staff				
Literature / Teaching materials	Literature will be announced at the beginning of term.			

Number: E 1	Title: <i>NanoBioPhysics and scanning probe microscopy</i>			Nature: Elective course
Credit points	3 CP			
Work load - contact hours (SWS) - self study	Total: 90 h contact hours: 30 h self-study (preparation for exams included): 60h			
Duration	1 semester			
Time schedule	The module is offered once per year in the summer term			
Language	German or English			
Number of participants	Maximum: 20			
Structure/Teaching methods	Lecture (2 SWS)			
Contents	<u>Thematic focus:</u> - Interactions on the nanoscale, measurement of inter- and intramolecular forces, contact models, technology of scanning probe microscopy, mechanical oscillations of nanostructures such as cantilevers, static and dynamic imaging modes, atomic force microscopy.			
Objectives	The module conveys the basics and in-depth knowledge of NanoBioPhysics and Scanning Probe Microscopy. After attending the module, students - have become familiar with a young field of nanobio-science - have acquired fundamental knowledge about the area of NanoBioPhysics - have learned interdisciplinary methods and applications of scanning probe microscopy - understand the basic phenomena, terms and concepts of NanoBioPhysics and Scanning Probe Microscopy - can solve simple problems in the field of NanoBioPhysics and Scanning Probe Microscopy - understand the connections between the various aspects of NanoBioPhysics and Scanning Probe Microscopy - have acquired experience in mathematically formulating and solving simple linear differential equations			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Lecture	Written exam (ca. 90 min) or oral exam	1-5	3 ECTS
Applicability	M.Sc. in Biomedical Technologies (elective course)			
Recommended semester	2 nd semester			
Participation requirements	B.Sc. degree			
Person responsible	Schäffer, Tilman, Prof., Dr. rer. nat.			
Teaching staff	Schäffer, Tilman, Prof., Dr. rer. nat.			
Literature/Teaching materials	Literature will be announced at the beginning of term.			

Number: E 17	Title: <i>Biostatistics of Clinical Studies</i>			Nature: Elective course
Credit points	3 CP			
Work load - contact hours (SWS) - self study	Total: 90 h contact hours: 45 h self-study (preparation for exams included): 90hours			
Duration	1 Semester			
Time schedule	Annual			
Language	English			
Number of participants	Lecture: no limit Tutorial: max. 28 participants			
Structure/ Teaching methods	Lecture 1 (2 SWS), Tutorial (1 SWS) (elective, English) 3 ECTS			
Contents	1) Introduction to clinical trials 2) Methods for diagnostic studies 3) Multivariable linear regression 4) Binary logistic regression 5) Survival analysis 6) Cox regression models 7) Estimates 8) Adaptive and sequential designs 9) Health services research 10) R Software tutorial			
Objectives	The student will be able to select the most appropriate statistical model for the research question and available data. Likewise, given the different types of analysis, the student will be able to obtain and interpret results depending on the type of model chosen. Furthermore, the student will be able to critical read papers on clinical studies, to apply checklists for clinical trials (e.g. CONSORT, STANDARD), to understand the content of clinical guidelines (ICH-GCP) and to write the statistical parts of applications (BMBF, DFG).			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	Course	Assessment	Grading Scheme	Weighting
	Tutorial	Oral examination	Passed or failed	3 ECTS
Applicability	M.Sc Biomedical Technology and M.Sc Medizinische Strahlenwissenschaften			
Recommended semester	1st / 2nd Semester			
Participation requirements	Prior completion of an introductory statistics course or equivalent basic statistical knowledge			
Person responsible	Martus, Peter, Prof. Dr. rer. nat. and Serna Higueta, Lina Maria PhD Peter.martus@med.uni-tuebingen.de; lina.serna-higueta@med.uni-tuebingen.de			
Literature/ Teaching materials	To be announced at the beginning of the term			

Number: MT	Title: <i>Master Thesis</i>			Nature: compulsory
Credit points	30 CP			
Work load - contact hours (SWS) - self study	Total: 900 h contact hours: 600 h self-study: 300 h			
Duration	6 months			
Frequency of the offer	each semester			
Language of instruction	English			
Number of participants	maximal 24			
Teaching methods	seminar (3 SWS), practical work (40 SWS)			
Content	depending on the project			
Qualification goals	Students are able to study published data to get insight a research field At the end of the master thesis the students should be able to develop an own research project idea and design and perform the appropriate experiments with help of published data. They understand the general flow from the idea of an experiment via the experimental design and methodology to interpretation of the results taking sufficient and appropriate controls and published data into account They have expertise in documentation, oral and written presentation of experimental data			
Requirements for credit points / exams and grading scheme (where appropriate, weighting)	course	assessment	Grading scheme	weighting
	Master Thesis	- oral presentation - written thesis	1-5 1-5	20% 80%
Usability	M.Sc. in Biomedical Technologies			
Recommended semester	4 th semester			
Prerequisite to attend the activities	Successful completion of the theoretical and practical course work in the 1 st , 2 nd and 3 rd semester			
Person responsible	The head of the examination committee			
Teacher	Various teachers of the faculty of Medicine, faculty of Science and Biomedical Technologies Industry			
Literature/Teaching materials	will be provided by the supervisor before start of master thesis			