

Module Compendium

for the Master's Degree Program Master of Science

Biomedical Sciences (BMS)

Valid as of October 2026

Faculty of Life Sciences

Study programme director: Prof. Dr. Dr. Isabel Burghardt

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1. Preliminary remarks

This module compendium serves the purpose of providing students and instructors a detailed and comprehensive description of the curriculum of the degree program Master of Biomedical Sciences.

The module descriptions present the module goals and intended results of study as well as the contents of the individual courses. Furthermore, all information necessary for academic success is given in the module descriptions. They are also included in the diploma supplement to the master's degree program.

If you have any questions regarding several modules or the course of studies, please contact the office of the Dean of the Faculty of Life Sciences.

If you have questions regarding a particular module, please contact the responsible module coordinator. You will find a list of the module coordinators in the Internet, where this module compendium can also be found.

If you have questions regarding a particular course, please contact the instructor.

2. Introduction

The curriculum of the master degree program for Biomedical Sciences comprises 3 semesters. The diploma is a professional qualification and enables graduates of biomedicine with a master's degree in natural science to work in industry or in academia.

Important structural elements of the course of studies are

- Two mandatory modules and four out of five elective modules in the winter term
- Project-oriented learning with 20 ECTS in the summer term
- Two out of three elective modules in the summer term
- A master's thesis, to be written within 6 months during the third semester.

The curriculum has been chosen so that graduates will be qualified to work in various fields, in particular in academic and industrial research in pharmaceuticals, medical technology (implants, regenerative medicine), biotechnology and diagnostics. The graduates' qualifications will be based on their education in the modern fields of material and surface sciences with regard to their application in biomedicine, but also on a profound knowledge of bioanalytics, pharmaceutical research and modern biotechnology. Students can start their studies both during winter or summer semester.

Modules in the **winter term** comprise two **mandatory** modules:

- Statistics in Biomedicine (BMSM01)
- Scientific methods (BMSM02)

These modules provide fundamental knowledge in the field of biomedical science.

In addition, also in the **winter semester**, **six modules** covering various fields in biomedical sciences are presented, of which **four modules are to be selected**:

- Analytical Methods in Biomedical Sciences (BMSW03)
- Materials and Applications in Biomedical Sciences (BMSW04)
- Microbiology & Virology (BMSW05)
- Lab automation and project management (BMSW14)
- Industry-Related Topics 2 (BMSW07)
- Neuroscience (BMSW015)

In the **summer term**, the main focus is laid on the **mandatory** module

- Project-Oriented Learning (BMSM12),

This module provides 20 ECTS. Objective is the education of the students in setting-up, planning and performing a project aiming at the solution of a specific research question.

Additionally in the **summer term**, **three modules** are offered, of which **two modules must be selected**:

- Biomedical Technologies & Regenerative Medicine (BMSW08)
- Advanced Pharmacology (BMSW09)
- Industry-Related Topics 1 (BMSW10)

The master's thesis shall be written in the third semester and can be done internally at Reutlingen University or at an external institute.

European Credit Transfer and Accumulation System (ECTS)

The Ministry for Science, Research and Art BW and the Conference of Ministers of Culture require the curriculum of study to be divided into modules. Students' performance is recorded by means of the „European Credit Transfer and Accumulation System“ (ECTS). In order to compare the performance of students at various institutions of higher learning—also foreign institutions—the ECT system is based not on the number of course hours per week, but rather on the time that students are required to invest in learning. In this way, student performance can be more objectively compared throughout Europe.

Full-time students can achieve 60 ECTS credit points per academic year. This approximates an average workload of 1800 hours of study. A credit point corresponds to 30 hours workload for a student of average intelligence and aptitude, whereby the workload includes the time during which the student attends class and his/her study time outside of class. Class time is given as weekly number of hours (à 60 minutes) per course (WH).

Example

WH*	Class attendance	Study time	Workload	Credit points
2	30h	60h	90h	3

WH* = 1 WH equals 15 hours per semester, which normally consists of 15 weeks.

Students can only obtain the ECTS points if the required exams have been successfully and verifiably absolved. Credit points are awarded according to the “all or none” principle.

3. Overview of the modules in the course of studies

Module	Courses	* W/S	** M/E	WH	ECTS
BMSM01: Statistics in Biomedicine	1.1: Medical Statistics 1.2: Multivariate Data Analysis	W	M	2 2	5
BMSM02: Scientific Methods	2.1: Quantitative Biology 2.2: Research Design	W	M	2 2	5
BMSW03: Analytical Methods in Biomedical Sciences	3.1: Analytical Methods in Biomedical Sci. 3.2: Diagnostic Technologies	W	E	2 2	5
BMSW04: Materials and Applications in Biomedical Sci.	4.1.: Functional Implants & Surface Technologies 4.2: Drug Research and Delivery Systems	W	E	2 2	5
BMSW05: Microscopy and Microbial / Viral Pathogens	5.1: Microscopy and Optics 5.2: Microbial / Viral Pathogens and Infection	W	E	2 2	5
BMSW07: Industry-Related Topics 2	7.1: Drug Discovery & Development 7.2: Introduction into Medical Technology	W	E	2 2	5
BMSW08: Biomedical Technologies & Regenerative Medicine	8.0: Biomedical Technologies & Regenerative Medicine	S	E	4	5
BMSW09: Advanced Pharmacology	9.1: Biomedical Pharmacology 9.2: Advanced Bioanalysis	S	E	2 2	5
BMSW10: Industry-Related Topics 1	10.1: Regulatory Affairs 10.2: IP Management	S	E	2 2	5
BMSW15: Neurosciences	15.1: Basics of Neurobiology 15.2: Neurobiology of disease	W	E	2 2	5
BMSW11: Modules from other Schools or Universities	11.0: Modules from other Schools or Universities	S	E	4	5
BMSM12: Project Oriented Learning	12.1: Information Retrieval and Evaluation 12.2: Research Seminar 12.3. Team Project	S	M	2 2 12	20
BMSM13: Master's Thesis	13.1: Master's Thesis Project and Defense 13.2: Research Seminar	3 3	M	- 2	30
BMSM14: Lab automation and project manamgmt	14.1. Lab automation 14.2. Project management	W	E	2 2	5
BMSW16: Internship semester (Add. Module only for stud. with 180 ECTS BSc's degree)	16.0: Internship semester	W/S	E	-	30

* Semester: W (Winter) / S (Summer)

**Type: M (Mandatory) / E (Elective)

4. Assignment of Marks / Assessment of Quality

Relative ECTS Marks

The international standard foresees that the best 10% of those students who pass receive the mark „A“, regardless of which mark they may receive according to the German marking system. With this system, the performance of students who have passed can be compared more objectively, taking into account that different courses may have different degrees of difficulty.

Student performance	ECTS mark
the best 10%	A = excellent
the next 25%	B = very good
the next 30%	C = good
the next 25%	D = satisfactory
the next 10%	E = sufficient
	F = failing

Since a large number of students are necessary in order to correctly calculate the relative ECTS marks, the conventional German marking system (1-5) shall be used and adapted as shown in the table below (valid as of February 2011).

ECTS mark	German mark	ECTS definition	German translation
A	1,0 – 1,3	Excellent	hervorragend
B	1,4 – 2,0	very good	sehr gut
C	2,1 – 2,7	Good	gut
D	2,8 – 3,5	Satisfactory	befriedigend
E	3,6 – 4,0	Sufficient	ausreichend
FX/F	4,1 – 5,0	Failing	nicht bestanden

5. Module description

Remarks Concerning the Description of Modules

The module descriptions are meant to offer students information regarding the course of studies, curriculum content, qualitative and quantitative requirements, the relationship of the individual modules to other modules and integration of the module into the general concept of the course of studies. The module descriptions are listed in tabular form.

The following remarks will help the reader to understand the terms used in the module descriptions. Module description / abbreviation:

A module name and abbreviation have been assigned to every module. The module name provides information about the content of the module. The corresponding abbreviation begins with the first letter of the name of the degree program. It ends with a number of a sequence of numbers. Thus, the abbreviation BMSM1 stands for the first module in Biomedical Sciences (the second „M“ stands for „Mandatory“, „W“ stands for „Elective“ = „Wahlpflichtmodul“).

Courses:

The courses included in a module are listed separately.

Semester:

The semester in which a module must be absolved is indicated.

Person responsible for the module:

This person is responsible for the editing of the module.

Instructor:

Instructors are responsible for the content and organization of their courses and/or those courses, which are held by an associate instructor.

Language:

The language in which the course is taught is indicated.

Integration with other courses of study:

In the event that a module is also offered in other courses of study, this shall be indicated.

Type of instruction/WH:

The type of instruction as well as the weekly hours of instruction are indicated in tabular form. The abbreviations stand for:

Lecture (L)

Exercise (E)

Lab work (LW)

Seminar (S)

BMSP01: Statistics in Biomedicine

Course of studies	Biomedical Sciences (MSc)					
Module	Statistics in Biomedicine					
Abbreviation	BMSM01					
Course(s)	Medical Statistics Multivariate Data Analysis (MDA)					
Semester	Winter					
Person responsible for the module	Prof. Dr. Rumen Krastev					
Instructor(s)	Dr. Nadejda Krasteva Prof. Dr. Karsten Rebner					
Language	English / German for MDA course					
Status within the curriculum	Mandatory					
Type of course / WH	Course		L	E	LW	S
	Medical Statistics		2			
	Multivariate Data Analysis (MDA)		1	1		
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Medical Statistics	30	45		75	
	Multivariate Data Analysis (MDA)	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Fundamentals of mathematics, IT, biology, chemistry, physics and/or medicine					
Module goals / desired outcome	<u>General knowledge:</u> • Ability to think statistically • Basic knowledge of statistical methods and multivariate data analyses • Basic knowledge of principles of experiment design and statistical learning					

	<u>Technical competences:</u> • Ability to use databases for simple data retrieval • Ability to identify and use appropriate methods in statistics • Ability to perform and interpret simple statistical methods and tests • Ability to recognize the limitations of statistical tests • Ability to develop linear and non-linear regression methods • Ability to design new multivariate models for a given data set • Ability to describe medical processes statistically • Ability to use the knowledge in approval processes for medical devices. • Ability to use software tools for statistics, data and image analysis and data visualization <u>Social competences and skills:</u> • Ability to research, interpret and present scientific results
Content	• Medical and pharmaceutical statistics Statistics in clinical practice: gathering, interpreting and presenting statistical data from medical studies Design of experiments for drug development, optimization and approval procedures Approval of test hypothesis in clinical studies • Multivariate Data Analysis Explorative Data Analysis (EDA); Principal Components Analysis; Statistical Learning and Model Selection ; Linear Regression Methods and Regression Shrinkage Methods
Study and exam requirements	Written exam (2h)
Media used	PowerPoint slides, flip charts, board, computer, software tools

Literature	• Statistical methods in medical research, P Armitage, G Berry, J N S Matthews, Blackwell Scientific Publications (Oxford, Boston) 2002 • Esbensen, Kim, et al. Multivariate Data Analysis: An Introduction to Multivariate Analysis, Process Analytical Technology and Quality by Design. Camo, 2018. • Kessler, W.: Multivariate Datenanalyse für die Pharma-, Bio- und Prozessanalytik, Wiley-VCH, 2007
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BMSP02: Scientific Methods

Course of studies	Biomedical Sciences (MSc)					
Module	Scientific Methods					
Abbreviation	BMSM02					
Course(s)	Quantitative Biology Research Design					
Semester	Winter					
Person responsible for the module	Prof. Dr. Ralf Kemkemer					
Instructor(s)	Prof. Dr. Ralf Kemkemer					
Language	English					
Status within the curriculum	Mandatory					
Type of course / WH	Course		L	E	LW	S
	Quantitative Biology		1	1		
	Research Design		1	1		
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Quantitative Biology	30	45		75	
	Research Design	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations (Studien- und Prüfungsordnung)					
Recommended knowledge / course work						
Module goals / desired outcome	<u>General knowledge:</u> Successful students will obtain • Overview of how to use relevant literature data bases with respect to scientific publications, patents, reviews, and monographs • Understanding of how search engines and citation management programs function and can be used					

	• Basic understanding of scientific institutions, scientific methods and history of science • Knowledge of principles of good scientific practice • Understanding of important concepts of research, e.g. hypothesis definition, literary research, planning of experiments, evaluation of experiments and data presentation • Understanding of science funding and scientific writing <u>Skills:</u> Successful students will be able • to conduct systematic and efficient scientific literature searches (source identification and exploitation) • to efficiently evaluate and document relevant publications and text/content therein • to cite literature correctly according to respective scientific standards and to save citations using citation managers • Understanding of advantages, disadvantages and limitations of scientific methods • Ability to design a basic research project and write a proposal therefore • Ability to plan a research project <u>Social competences:</u> • Ability to work in a self-organized manner and as a member of a team • Ability to do work target-oriented and systematically
Content	<u>Quantitative Biology</u> <u>Research Design</u> • Principles of scientific methods and history • Structure and organization of German and international scientific institutions • Principles of science funding

	• Principles of scientific research and literary research with practical examples • Aspects of a scientific project (hypothesis, planning, research, financing, data evaluation,...) • Scientific writing (proposals, publications), review process
Study and exam requirements	Presentation, assignments, proposal
Media used	Lecture, board, overheads, lecture notes, handouts, exercise sheets, software practicals in CIP-pool
Literature	• Research Methods for the Biosciences, 2nd Edition, D. Holmes, P. Moody, and D. Dine, Oxford University Press 2011 • Scientific Publications

BMSW03: Analytical Methods in Biomedical Sciences

Course of studies	Biomedical Sciences (MSc)					
Module	Scientific Methods					
Abbreviation	BMSW03					
Course(s)	Analytical Methods in Biomedical Sciences Diagnostic Technologies					
Semester	Winter					
Person responsible for the module	Prof. Dr. Günther Proll					
Instructor(s)	Prof. Dr. Jeannette Hübener-Schmid Prof. Dr. Günther Proll					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course		L	E	LW	S
	Analytical Methods in Biomedical Sciences		1			1
	Diagnostic Technologies		2			
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Analytical Methods in Biomedical Sciences	30	45		75	
	Diagnostic Technologies	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Knowledge of biochemistry, bioanalytics, instrumental analytics, chemistry, material science, biology					
Module goals / desired outcome	<u>General knowledge:</u> Successful students will obtain • Profound overview of current bioanalytical techniques that are significant in biomedical and pharmaceutical research					

	• Profound understanding of materials for diagnostic applications • Profound understanding of technologies and functioning of laboratory diagnostics, point-of-care testing and applications • Fundamental understanding of principles of cell biology, and molecular biology <u>Skills:</u> • Understanding of complex relationships in bioanalytics • Understanding of the aspects of -OMICS that are relevant for R&D in biotechnology, pharmaceutical and diagnostics industries • Understanding of principles of interaction of biological systems and molecules with materials • Understanding of principles of structure of diagnostic systems and prerequisites for certain applications • Ability to name limitations of existing technologies • Ability to evaluate various methods of laboratory diagnostics • Ability to read and understand scientific publications <u>Social competences:</u> • Ability to prepare and deliver a scientific presentation for a seminar • Ability to do scientific research and to present scientific findings
Content	• Analytical Methods in Biomedical Sciences The course consists of a lecture and a seminar. Students must choose a research topic on which they will prepare and hold a scientific presentation. The following fields of study will be covered in the lecture and seminar: - Biomarkers

	- Different “Omics” technologies including genomics, transcriptomics, proteomics, and metabolomics - Analyses in the field of neuroscience - Selected topics of bioanalysis e.g. , epigenomics, ultra-long sequencing, single cell sequencing • Diagnostic Technologies Structure, function and application of laboratory diagnostic methods, in particular micro-technologies and microfluidics, lab-on-a-chip technology, Bio-MEMS, point-of-care testing, personalized medicine, companion diagnostics, AI in diagnostics
Study and exam requirements	Written exam (2h), presentation, term paper
Media used	Lecture, script as download, board, student presentations, digital projector, handouts
Literature	• Jens Kurreck, Joachim W. Engels, Friedrich Lottspeich, Bioanalytik, Springer-Verlag GmbH Berlin 2022 • Albert Folch, Introduction to BioMEMS, CRC Press (2013) • Peter Lippa, POCT - Patientennahe Labordiagnostik, Springer (2017) • Strachan T, Read AP, Matson RS, Human Molecular Genetics, CRC Press (2018). • Barh D, Blum K, Madigan MA, OMICS – Biomedical Perspectives and Applications, CRC Press (2012) • Rehm, H., Letzel, T.: Der Experimentator – Proteinbiochemie/Proteomics, Spektrum Verlag • Scientific publications

BMSW04: Materials and Applications in Biomedical Sciences

Course of studies	Biomedical Sciences (MSc)					
Module	Materials and Applications in Biomedical Science					
Abbreviation	BMSW04					
Course(s)	Functional Implants & Surface Technologies Drug Delivery and Release Systems					
Semester	Winter					
Person responsible for the module	Prof. Dr. Xin Xiong					
Instructor(s)	Prof. Dr. Xin Xiong					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course		L	E	LW	S
	Functional Implants & Surface Technologies		2			
	Drug Delivery and Release Systems		2			
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Functional Implants & Surface Technologies	30	45		75	
	Drug Release and Delivery Systems	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Basic understanding (BSc-level) of chemistry, biology and biomedical technology, material sciences					
Module goals / desired outcome	<u>General knowledge:</u> • 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					

	• Understanding of core concepts of pharmacokinetics and pharmacodynamics • Understanding of the mechanisms of drug release under various conditions and application of biomaterials • Understanding analytical techniques to characterize the drug delivery systems, <u>Technical competences:</u> • Students will be able to understand surface and polymer technologies and transfer these to appropriate applications in the biomedical field • Students will be able to understand principles of functional implants and drug delivery systems • Students will understand the complexity of tissue–material interactions and relate them to material properties and applications • Students will apply physicochemical and biological characterization methods • Students will evaluate the suitability of different material classes for specific applications • Students will identify the limitations of current technologies <u>Social competences:</u> • Students develop skills in research, reading and interpreting scientific texts • Students gain an awareness of ethical & regulatory aspects in the development of medical products.
Content	• Functional Implants & Surface Technologies - Materials and design principles of passive and active implants - Examples and applications of functional implants - Technical principles of active implants (with examples) - Micro- and nanotechnology in implant design - Surface chemistry and modification strategies

	- Interactions of cells and biological molecules with materials and surfaces - Techniques for characterizing medical surfaces and implants • Drug Release and Delivery Systems - Core principles of pharmacokinetics and pharmacodynamics - Formulations and systems for effective drug delivery; Manufacturing technologies - Release mechanisms: diffusion, degradation, swelling, and affinity-based processes - Delivery of “biologicals” e.g. peptides, proteins, antibodies, vaccines and gene therapeutics - Controlled and targeted delivery: site- and time-specific approaches - Example technologies: thin polymer films, responsive and targeted delivery, liposomes.
Study and exam requirements	Written exam (2h), presentation /assignments
Media used	PowerPoint slides, flip charts, board
Literature	• Functional Biomaterials, Mohan et al., Wiley, 2023. ISBN: 9783527347711 • Physical and chemistry of interfaces, Butt et al., Wiley, 2003. ISBN: 9783527404131 • Biomaterial Sciences, Wagner et al., Elsevier, 2020 ISBN: 9780128161371 • Drug delivery: Fundamentals and Applications, CRC Press, 2017, Hillery et al., ISBN: 9781482217711 • Pharmaceutical Dosage Forms and Drug Delivery, Mahato et al., Routledge, 2025. ISBN: 9781032480602

BMSW05 - Microscopy and Microbial / Viral Pathogens

Course of studies	Biomedical Sciences (MSc)					
Module	Microscopy and Microbial / Viral Pathogens					
Abbreviation	BMSW05					
Course(s)	Microscopy and Optics Microbial / Viral Pathogens and Infection					
Semester	Winter					
Person responsible for the module	Prof. Dr. Günther Proll					
Instructor(s)	Prof. Dr. Günther Proll Dr. Doğan Doruk Demircioğlu					
Language	English and German					
Status within the curriculum	Elective module					
Type of course / WH	Course	L	E	LW	S	
	Microscopy and Optics	2				
	Microbial / Viral Pathogens and Infection	2				
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Microscopy and Optics	30	45		75	
	Microbial / Viral Pathogens and Infection	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	None					
Recommended knowledge / course work	Basic understanding of physics, microbiology, biochemistry (BSc level)					
Module goals / desired outcome	<u>Microscopy and Optics</u> Students have a detailed knowledge of geometrical and ray optics (K1)					

	• Students understand the formation of images by Basic understanding of physics, microbiology, biochemistry (BSc level) lenses (K2) • Students understand the difference between geometrical and wave optics (K2) • Students are able to solve problems of intermediate complexity (K3) • Students are able to construct images formed by a simple lens system (e.g. a microscope) (K3) • Students have a profound knowledge of the most relevant microscopic techniques (K1) • Students are able to assign a problem to the most relevant microscopy techniques (K4) • Students are able to analyze a given microscopy technique and find out the most relevant relations (K4) • Students create and give an oral presentation about a microscopic technique for other students (K6) <u>Microbial / Viral Pathogens and Infection</u> • Students can classify viruses and bacteria into categories. • Based on the cellular structure of bacterial cell walls, they can classify bacteria. • They understand the mechanisms of infection pathways. • Students are able to describe different toxins and explain their effects on humans. • They know the importance of vaccinations in preventing infectious diseases and understand the mechanisms of immunization. • They have learned the basics of epidemiology. • They are able to identify different techniques for inactivating pathogens and apply them to examples.
Content	<u>Microscopy and Optics</u>

- Optical technologies are a cornerstone of many analytical technologies. The lecture begins with a brief review of geometrical optics. We discuss wave optics in free space and look at aberrations of optical elements, lens design and technical optics.
- In the second part, we focus on microscopy and discuss the resolution of a conventional microscope, as well as fluorescence microscopy and the confocal microscope. Furthermore, the methods TIRF and FRET, as well as methods for resolution enhancement such as structured illumination, 4Pi, STED, STORM and FLIM microscopy are discussed.
- Furthermore, resolution enhancements through software solutions as well as automated microscopy techniques and AI-based approaches are discussed.
- Examples of applications are given in all parts.

Microbial / Viral Pathogens and Infection

- Students will understand the fundamentals of microbiology/virology, including viral and bacterial taxonomy, metabolism etc.
- Students will understand basic concepts of Microbial Genetics
- Students will understand what a disease is, what causes a disease and how the human immune system clears an infectious disease
- Students will understand the enormous and diverse impact of microbiota/the microbiome on humans
- Students will understand the importance of vaccinations for the prevention of infectious diseases caused by Gram-negative or positive pathogens or viruses and understand the underlying mechanism of immunization
- Students will learn how antibiotics work, why AMR is a global health concern and how to tackle it
- Students will get an overview of virus biology and antiviral chemotherapy

Study and exam requirements	Written exam (2h), presentation
Media used	Lecture, board, digital projector, handouts
Literature	• Hecht, E.: Optics, Addison-Wesley, 2001 • Murphy, D.B.: Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Blackwell; 2nd ed. 2012 • Jens Kurreck, Joachim W. Engels, Friedrich Lottspeich, Bioanalytik, Springer-Verlag GmbH Berlin 2022 • Modrow, S.; Molekulare Virologie; Spektrum Akademischer Verlag, 2022 • Allgemeine Mikrobiologie, Thieme, 2021 • Brock Microbiology of Microorganisms, Global Edition, 2021 • Jane Flint, Vincent R. Racaniello et al.: Principles of Virology, 2020 • Scientific publications

BMSW07: Industry-Related Topics 2

Course of studies	Biomedical Sciences (MSc)					
Module	Industry-Related Topics 2					
Abbreviation	BMSW07					
Course(s)	Drug Discovery & Development Introduction into Medical Technology					
Semester	Winter					
Person responsible for the module	Prof. Dr. Jörg Mittelstät					
Instructor(s)	Dr. Tim Sonntag Dr. Andreas Schüle					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course		L	E	LW	S
	Drug Discovery & Development		2			
	Introduction into Medical Technology		2			
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Project Management	30	45		75	
	Innovation Management	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	• Basic understanding, knowledge of the principles of pharmaceutical and medical technology industries • Basic knowledge of natural sciences • Basic knowledge of the pharmaceutical and medical technology industries					
Module goals / desired outcome	Understanding of strategic and operational topics concerning drug discovery, drug development, medical and biomedical technologies.					

	In “<u>Drug Discovery and Development</u>”, students will receive information on state-of-the-art developments, research, and expert opinions in the pharmaceutical industry. Furthermore, the key success factors in research and development (R&D) as well as value creators in pharmaceutical innovation will be discussed. The topics addressed include the innovation process, pharmaceutical R&D, research and innovation strategies. Students will gain an overview of the pharmaceutical industry and how pharmaceutical R&D works operationally. In the “<u>Introduction to Medical Technology</u>”, students will gain a basic understanding of fundamental technologies in bio-medical engineering, focusing on the medical background and basic principles of related methods (MRT, CT, sonography, PET, dialysis, heart-lung machine, artificial lungs, stents, heart valves, pace makers). Students will know: • the definition of biomedical engineering and • the basic principles and medical background of different technologies. Thus, students will improve their ability to • understand and use new vocabulary • read, summarize and discuss scientific topics and • prepare and present scientific results in the form of short presentations in teams.
Content	<u>Drug Discovery and Development</u> • Global epidemiology • Pharma-economics • Financing of innovation • Drug targets • Preclinical safety • Pharmaceutical development • Translational medicine • Clinical development • Biologics and ATMPs • Bioequivalence and Biosimilars

	• Regulatory considerations • Pharmaceutical strategies <u>Introduction to Medical Technologies</u> Introduction • Definition • Overview • Short summary of the basics Medical background and technology fundamentals: Medical imaging • MRT • CT • Sonography • PET • etc. Life support systems • Dialysis • Heart-lung machine • Artificial lung • etc. Implants • Stent • Heart valve • Cochlear • Retinal
Study and exam requirements	Preparation and presentation of at least one scientific topic in the module; written examination (2 hours)
Media used	Lecture, group work, interactive discussions, handouts, flip charts
Literature	• Blass BE, Basic Principles of Drug Discovery and Development, 2nd Edition, Elsevier Academic Press, 2021 • Hill RG, Richards DB, Drug Discovery and Development – Technology in Transition, 3rd Edition, Elsevier. • 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 • Ratner, B. D., Hoffman A.S. et al. (eds.): Biomaterials Science - An Introduction to Materials in Medicine, Elsevier Academic Press, 2004 • Joseph Bronzino and Donald R. Peterson : The Biomedical Engineering Handbook, Fourth Edition: Four Volume Set, Crc Pr Inc; 2015 • Pierre Morgon (2014) Sustainable Development in the Healthcare System, Springer
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BMSW08 – Biomedical Technologies & Regenerative Medicine

Course of studies	Biomedical Sciences (MSc)					
Module	Biomedical Technologies & Regenerative Medicine					
Abbreviation	BMS08					
Course(s)	• Biomedical Technologies • Regenerative Medicine					
Semester	Summer					
Person responsible for the module	Prof. Dr. Dr. Isabel Burghardt					
Instructor	Dr. Julia Rogal Dr. Madalena Cipriano					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course	L	E	LW	S	
	Biomedical Technologies	1	1			
	Regenerative Medicine	2				
Workload in hours	Course	Class attendance		Study outside of class	Total	CP
	Biomedical Technologies	30		45	75	
	Regenerative Medicine	30		45	75	
	Total	60		90	150	5
Credit points						
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Cell biology, physiology, cell culture, biomaterials, tissue engineering, biomedical engineering					

Module goals / desired outcome	• students get insight into microphysiological systems (MPS) as new approach methodologies to reduce animal experimentation (including spheroids, organoids, organ-on-chip as well as microfabrication) for future perspectives in biomedical engineering students can: • define the term ‘microphysiological system (MPS)’ • explain basic principles the of organoid- and organ-on-chip technology, including their (non-)clinical applications • explore the potential of microfluidics for increasing the complexity and relevant of in vitro testing • distinguish different microfabrication technologies, their characteristics and their pros & cons • analyze (bio-)materials and different cell sources for their use in in vitro models and their limitations • create digital models of microfluidic platforms by Computer aided design programs • evaluate potential applications of MPS in biomedical sciences including drug development, disease modeling and toxicology • define the term regenerative medicine • compare characteristics of stem cells and their (pre-)clinical use • analyze different matrix components and their properties as well as the potential (pre-)clinical applications of different matrices • explain basic contents of the regulatory framework • evaluate the state of the art in selected applications and the challenges students improve their ability in: • understanding and use new vocabulary • read, summarize, discuss and evaluate scientific topics • prepare and present results and short presentations
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Content	• Biomedical Technologies – Microphysiological Systems & Microfabrication: • • Introduction Microphysiological Systems (MPS) • Organoids [basics and (non-)clinical applications] • Organs-on-chip (OoCs) basics: single OoCs, multi OoCs; applications of OoCs with focus on oncology and toxicology • Overview of different microfabrication technologies • CAD of OoC models files • Regenerative Medicine & Biofabrication: • Definition and short summary of fundamentals • Stem cells [basics and (pre-)clinical applications] • Matrix [basics and (pre-)clinical applications] • State-of-the-art (pre-)clinical applications • Regulatory affairs and market • Several field trips to laboratories/companies focused on organoid- & OoC-research as well as matrix
Study and exam requirements	• One written exam for the module (120 min), presentation
Media used	• Lecture, interactive discussions, group work, flip chart, PCs, presentations
Literature	• Gustav Steinhoff, Regenerative Medicine: From Protocol to Patient, Springer 2013 • Joseph Bronzino and Donald R. Peterson : The Biomedical Engineering Handbook, Fourth Edition: Four Volume Set, Crc Pr Inc; 2015 • A. Mosig, J. Nawroth, P. Loskill. Standpunkt: Organs-on-a-Chip: Neue Perspektiven in der Medikamenten-entwicklung und Personalisierten Medizin. DZKF. 1/2017. • Marco Rasponi, Organ-on-a-Chip – Methods and Protocols, Springer Protocols, 2022 • M. Mastrangeli, S. Millet, C. Mummery, P. Loskill, D. Braeken, W. Eberle, M. Cipriano, L. Fernandez, M. Graef, X. Gidrol, N. Picollet-D'Hahan, B. van Meer, I. Ochoa, M. Schutte, J. van den Eijnden-van Raaij • Organ-on-chip in development: Towards a roadmap for organs-on-chip, ALTEX, 2019, 36, 650-668, https://doi.org/10.14573/altex.1908271 • M. Mastrangeli, S. Millet, C. Mummery, P. Loskill, D. Braeken, W. Eberle, M. Cipriano, L. Fernandez, M. Graef, X. Gidrol, N. Picollet-D'Hahan, B. van Meer, I. Ochoa, M. Schutte, J. van den Eijnden-van Raaij • Building blocks for a European Organ-on-Chip roadmap, ALTEX, 2019, 36, 481-492 , https://doi.org/10.14573/altex.1905221 • Kim, J., Koo, BK. & Knoblich, J.A. Human organoids: model systems for human biology and medicine. Nat Rev Mol Cell Biol 21, 571–584 (2020). https://doi.org/10.1038/s41580-020-0259-3

	• Ingber, D.E. Human organs-on-chips for disease modelling, drug development and personalized medicine. Nat Rev Genet 23, 467–491 (2022). https://doi.org/10.1038/s41576-022-00466-9
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BMSW09: Advanced Pharmacology

Course of studies	Biomedical Sciences (MSc)					
Module	Advanced Pharmacology					
Abbreviation	BMSW09					
Course(s)	Biomedical Pharmacology Advanced Bioanalysis					
Semester	Summer					
Person responsible for the module	Prof. Dr. Jörg Mittelstät					
Instructor(s)	Prof. Dr. Jörg Mittelstät Prof. Dr. Günther Proll					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course	L	E	LW	S	
	Biomedical Pharmacology	2				
	Advanced Bioanalysis	2				
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	BiomedicalP harmacology	30	45		75	
	Advanced Bioanalysis	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Knowledge of biochemistry, bioanalytics and instrumental analytics, biology, fundamentals of pharmacology, cell biology, immunology and molecular biology					
Module goals / desired outcome	<u>General knowledge:</u> Profound overview of current bioanalytical techniques relevant for biomedical as well as pharmaceutical research					

	• Understanding of the principles, manufacturing and regulatory framework of modern advanced therapies (ATMPs) • Understanding of the mode of action of cell-based, gene-based and immune-modulating therapies <u>Skills:</u> • In-depth knowledge of the design and mechanism of action of cell and gene therapies • In-depth knowledge of immunotherapies (monoclonal antibodies, bispecific antibodies, checkpoint inhibitors, cancer vaccines, cytokine-based approaches) • Understanding of immune effector mechanisms and translational immunology • Understanding of the use of modern analysis systems and biosensors in drug development and personalized medicine • Understanding of the functioning of microarray-systems and multiplexing • Ability to read and understand scientific publications <u>Social competences:</u> • Preparation and presentation of a scientific presentation for a seminar • Ability to do scientific research and present scientific findings
Content	<u>Analytical Methods in Biomedical Sciences</u> • Special instrumental analysis • Imaging methods • Biosensors • Characterization of viral vectors • In silico analysis • Automation in drug discovery • Effect-directed analytics <u>Advanced Therapies</u>

	• <u>Fundamentals of advanced therapy medicinal products (ATMPs): regulatory and quality requirements, GMP aspects</u> • <u>Cell therapies: adoptive T-cell therapy, CAR-T cells, TCR-engineered cells, stem-cell-based approaches,</u> • <u>Gene therapies</u> • <u>Immunotherapies: monoclonal and bispecific antibodies, checkpoint inhibitors, cancer vaccines, oncolytic viruses, cytokine-based therapies</u> • <u>Immune-related adverse events,</u> • <u>Translational aspects</u> •
Study and exam requirements	written examination (2 hours)
Media used	Lecture, script for download, board, digital projector, handouts
Literature	• Jens Kurreck, Joachim W. Engels, Friedrich Lottspeich, Bioanalytik, Springer-Verlag GmbH Berlin 2022 • Karl Cammann, Instrumentelle Chemie, Spektrum Akademischer Verlag GmbH (2001) • Günter Gauglitz, David S. Moore, Handbook of Spectroscopy, Wiley-VCH Verlag GmbH & Co. KGaA (2010) • Ullmann`s Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA (2016) • Anna Sureda, Selim Corbacioglu, Raffaella Greco, Nicolaus Kröger, Enric Carreras, The EBMT handbook: hematopoietic cell transplantation and cellular therapies, Springer-Verlag, 2024 • Peer-reviewed articles

BMSW10: Industry-Related Topics 1

Course of studies	Biomedical Sciences (MSc)					
Module	Industry-Related Topics 1					
Abbreviation	BMSW10					
Course(s)	Regulatory Affairs IP Management					
Semester	Summer					
Person responsible for the module	Prof. Dr. Xin Xiong					
Instructor(s)	Prof. Dr. Xin Xiong					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course	L	E	LW	S	
	Regulatory Affairs	2				
	IP Management	2				
Workload in hours	Course	Class Attendance	Study outside of class	Total	CP	
	Regulatory Affairs	30	45	75		
	IP Management	30	45	75		
	Total	60	90	150	5	
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	No specific knowledge required					
Module goals / desired outcome	The primary goal is to understanding the strategic and operational relevance of <u>regulatory affairs</u> and intellectual property (IP) rights for high-tech industries, such as the pharmaceutical, biotechnology and medical device industries. More specifically, it is the understanding of formalities in the development and manufacturing of medical devices and					

	pharmaceutical products – with a focus of the respective national and international registration and authorization rules. In <u>Intellectual Property (IP) Management</u>, students will gain knowledge of the international and European patent laws, patentability requirements, how to file a patent application and the writing of patent claims.
Content	<u>Regulatory affairs</u> • FDA • EMEA, MDR, IVDR • ICH • Development and validation of analytical procedure • Life cycle regulation, risk and quality management <u>IP Management</u> • European Patent Convention and Patent Cooperation Treaty • Filing a patent application • Searching for patents • Patentability analysis • Writing patent claims
Study and exam requirements	written examination (2 hours)
Media used	Lecture, script for download, board, digital projector, handouts
Literature	• The European Patent Convention (http://documents.epo.org/projects/babylon/eponet.nsf/0/00E0CD7FD461C0D5C1257C060050C376/\$File/EPC_15th_edition_2013_de_bookmarks.pdf) • National and international guidelines as accessible via FDA and EMEA • David Mantus & Douglas J. Pisano, FDA regulatory affairs, ISBN-13:978-1841849195 • Medical regulatory affairs ISBN: 9789814877862

BMSW15: Neurosciences

Course of studies	Biomedical Sciences (MSc)					
Module	Neuroscience					
Abbreviation	BMSW15					
Course(s)	Basics of Neurobiology Neurobiology of disease					
Semester	Winter					
Person responsible for the module	Prof. Dr. Ebru Ercan Herbst					
Instructor(s)	Prof. Dr. Ebru Ercan Herbst					
Language	English					
Status within the curriculum	Elective module					
Type of course / WH	Course		L	E	LW	S
	Basics of Neurobiology		1			1
	Neurobiology of disease		1			1
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Basics of Neurobiology	30	45		75	
	Neurobiology of disease	30	45		75	
	Total	60	90		150	5
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Cell biology, biochemistry, bioanalytics, biology, physiology					
Module goals / desired outcome	<u>General knowledge:</u> Successful students will obtain: • Profound overview of how central and peripheral nervous system works. • Knowledge on human brain anatomy and functions of different regions and brain cell types and their roles.					

- Profound understanding of neurological disease mechanisms
- Profound knowledge on the methods and model organisms used in neuroscience.
- Fundamental knowledge on disease diagnosis in neuroscience.
- Profound understanding of using induced pluripotent stem cells (iPSCs) in neuroscience research.

Technical competences:

- Understanding of the anatomy of the brain, neural circuits and its region-specific functions.
- Understanding of the cellular architecture of the brain and functions of different brain cell types.
- Knowledge on neurodevelopmental and neurodegenerative disorders and their recent pharmacological interventions.
- Ability to name the techniques used in neuroscience research.
- Knowledge on model organisms to study neurological disorders and behaviour.
- Ability to present behavioral analyses performed in neuroscience research using model organisms.
- Ability to name the clinical criteria for diagnostics in neurological diseases.
- Understanding of cell-based experimental approaches for studying brain cell functions in health and disease.

Competences:

- Gaining in-depth knowledge about a specific topic depending on the specified research question in the field of medical neuroscience.
- Develop analytical and critical thinking by selecting the appropriate scientific methodology depending on the specific research question.
- Properly present and scientifically sound defense their own study in front of peers.

	• Discuss competently research results comparing findings to each other (literature-based). <u>Social competences:</u> • Preparation and presentation of a scientific presentation for a seminar. • Ability to design scientific research and present scientific findings. • Team work competence: Group discussions and case study analysis. • Able to think conceptually, work beneficial together in project teams and have developed and strengthened their team and communication skills.
Content	Basics of Neurobiology • Human brain anatomy and functions of the brain • Cellular components of the nervous system • Brain architecture of the human and its comparison to model organisms • Blood brain barrier: The Blood Supply of the Brain and Spinal Cord • Electrical Signals of Nerve Cells • Synaptic Transmission and roles of neurotransmitters: Neurotransmitter Receptors and Their Effects • Construction of Neural Circuits and Modification of Brain Circuits as a Result of Experience • Model organisms used in neurobiology research (student presentations) • Behavioral tests used in neuroscience (student presentations) Neurobiology of Disease

	• Molecular disease mechanisms of neurodevelopmental and neurodegenerative disorders • Clinical diagnosis of neurological disorders • Clinical research trials on select neurological diseases • Laboratory methods in neuroscience research (cell-based, primary cells, iPSCs, 3D cell cultures, etc.)
Study and exam requirements	Written exam (2h), presentation
Media used	Lecture script as download, board, student presentations, digital projector, handouts, videos.
Literature	• Neuroscience, 2nd edition. Editors: Dale Purves, George J Augustine, David Fitzpatrick, Lawrence C Katz, Anthony-Samuel LaMantia, James O McNamara, and S Mark Williams. Sunderland (MA): Sinauer Associates; 2001. ISBN-10: 0-87893-742-0 • Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 6th edition. Siegel GJ, Agranoff BW, Albers RW, et al., editors. Philadelphia: Lippincott-Raven; 1999. • Methods of Behavior Analysis in Neuroscience. 2nd edition. Buccafusco JJ, editor. Boca Raton (FL): CRC Press/Taylor & Francis; 2009. • Introduction to Neuroscience. Valerie Hedges, East Lansing, MI. Copyright Year: 2022. ISBN 13: 9781626101227 • Scientific research and review papers on all topics (Source: PubMed, Elsevier, etc.)

BMSW11: Modules from other Schools or Universities

Course of studies	Biomedical Sciences (MSc)					
Module	Modules from other Schools or Universities					
Abbreviation	BMSW11					
Course(s)	Elective course					
Semester	Summer					
Person responsible for the module	Prof. Dr. Dr. Isabel Burghardt					
Instructor(s)	Instructors from other Schools or Universities					
Language	English or German					
Status within the curriculum	Elective module					
Type of course / WH	Course	L	E	LW	S	
	Elective Subject I	2				
	Elective Subject II	2				
Workload in hours	Course	Class Attendance	Study outside of class	Total	CP	
	Elective Subject I	30	45	75		
	Elective Subject II	30	45	75		
	Total	60	90	150	5	
Credit points	5					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	None					
Module goals / desired outcome	Dependent on elective					
Content	Dependent on elective					
Study and exam requirements	Students must document successful participation in a university course					
Media used	Dependent on elective					
Literature	Dependent on elective					

BMSP12: Project Oriented Learning

Course of studies	Biomedical Sciences (MSc)					
Module	Project Oriented Learning					
Abbreviation	BMSM12					
Course(s)	Information Retrieval and Evaluation Research Seminar Team Project					
Semester	Summer					
Person responsible for the module	Prof. Dr. Dr. Isabel Burghardt					
Instructor(s)	All instructors within the faculty or instructors designated by the examination committee					
Language	English and German					
Status within the curriculum	Mandatory					
Type of course / WH	Course	L	E	LW	S	
	Information Retrieval and Evaluation				2	
	Research Seminar				2	
	Team Project			12		
Workload in hours	Course	Class Attendance	Study outside of class	Total	CP	
	Information Retrieval and Evaluation	30	45	75		
	Research Seminar	30	45	75		
	Team Project	180	270	450		
	Total	240	360	600	20	
Credit points	20					
Prerequisites for attending this course	For reasons of occupational safety, the students have to prepare the theoretical and practical contents of the module prior to starting practical work in the laboratory. Proof of this is provided by successful participation in a safety and / or introductory colloquium (written or oral).					

Recommended knowledge / course work	Fundamentals in Chemistry, Physics and Biochemistry
Module goals / desired outcome	Objective is the education of the students in setting-up, planning and performing a project aiming at the solution of a specific research question. After successful completion of this module students: • understand how search engines and citation management programs function and can be used (K2). • use relevant literature data bases with respect to scientific publications, patents, reviews, and monographs (K3). • conduct systematic and efficient scientific literature searches (source identification and exploitation) (K3). • cite and organize literature correctly according to respective scientific standards and to save citations using citation managers (K4) • evaluate and efficiently document relevant publications and text/content therein (K5). • can define a research project: how to structure complex scientific questions and break them down into single steps like formulating state of the art and formulating scientific hypotheses. (K6) • successfully apply tools for practical project planning and coordination (Gantt-diagrams, decision gates, milestones, deliverables, etc.). (K5) • professionally apply tools for practical project management (action items, meeting organization, work documentation, efficient use of resources, coordination, etc.). (K4) • effectively extract information from technical and scientific databases and evaluate it with regard to a specific research question. (K4) • gain in-depth knowledge about a specific topic depending on the specified research question. (K3) • select the appropriate scientific methodology depending on the specific research question. (K4)

	• are able to think conceptually, work beneficial together in project teams and have developed and strengthened their team and communication skills. (K5) • properly present and scientifically sound defense their own findings in front of a panel of experts (= council of supervisors) (K5) • discuss competently experimental results in the light of the state of the art and comparing own findings to the scientific literature. (K4) • assimilate to novel research questions, adapt to / orientate in a new field. (K5) • are able to work in a self-organized manner and as a member of a team and do their work target-oriented and systematically. (K6)
Content	Information Retrieval and Evaluation • Reference data bases, search engines, citation managers • Literature search examples/exercises based on concrete scientific questions Team Project and Research Seminar The students will work in teams on a defined research question. The research question is defined by the supervisor at the faculty and will be in accordance with current research activities at the department. The students will prepare a scientific and technological state of the art on this research question and based on this they will define a project plan addressing all relevant issues of a real research project (time schedule, resource plan, objectives, means to arrive at the objectives, required methods, hypotheses, etc.). This project plan will be disseminated as a formal project application with a special focus on a comprehensive state of the art. No single-person projects are admissible and all projects are hosted by the faculty exclusively. The actual research project plan set up by the students will then be realized. The students will perform the necessary scientific and

	technological experiments based on the state of the art on this research question and their research proposal. The students organize their project by themselves and are guided by the supervising professor.
Study and exam requirements	Study requirements: oral presentation of project plan during semester Exam requirements: Written seminar paper (= state of the art) (50%) Final project report (35%) Final project defense (15%), including oral presentation and/or poster presentation
Media used	Lecture, board, digital projector, handouts
Literature	• Chalmers AF (2007) Wege der Wissenschaft. Einführung in die Wissenschaftstheorie, 6. Auflage, Nachdruck, Springer • Patzak G, Rattay G (2004) Projektmanagement, 4. Auflage, Linde International • Baguley P (1999) Optimales Projektmanagement, Falken • Scientific Original papers, depending on the specific research question • H.F. Ebel et al. (2006) Schreiben und Publizieren in den Naturwissenschaften, Wiley-VCH Weinheim. • Others, dependent on topic of research project

BMSM13: Master's Thesis

Course of studies	Biomedical Sciences (MSc)					
Module	Master's Thesis					
Abbreviation	BMSM13					
Course(s)	Master's Thesis Project and Defense (internal/ external) Research Seminar to Master's Thesis					
Semester	3					
Person responsible for the module	Prof. Dr. Dr. Isabel Burghardt					
Instructor(s)	All instructors within the faculty					
Language	English and German					
Status within the curriculum	Mandatory					
Type of course / WH	Course	L	E	LW	S	
	Master's Thesis Project and Defense (internal/ external)					
	Research Seminar to Master's Thesis				2	
Workload in hours	Course	Class Attendance	Study outside of class	Total	CP	
	Master's Thesis Project and Defense (internal/ external)		840	840	28	
	Research Seminar to Master's Thesis	30	30	60	2	
	Total	240	360	600	30	
Credit points	30					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Successful completion of research project					
Module goals / desired outcome	Ability to implement acquired research abilities within a defined research project					
	<u>General knowledge</u> Ability to do detailed and in-depth research on a defined scientific field of study					
	<u>Skills</u>					

	• Ability to work independently in a team on a defined research project • Ability to evaluate and implement insights / findings of scientific literature • Ability to prepare and present scientific results <u>Technical competences</u> • Ability to apply modern strategies for finding scientific solutions <u>Social competences</u> • Ability to promote team work in a research group
Content	Students will work independently on a defined research project, preferably in a research group at the Reutlingen University or at an external research institute (e.g. NMI at the University of Tübingen or the Fraunhofer Institute in Stuttgart). Students will work under the direction of a professor of our faculty. Their work will culminate in a master's thesis, to be written by each student individually and independently. The thesis work may also be done in an industrial R&D department, provided a professor of the Faculty of Life Sciences supervises the project. Each student will research a defined scientific topic, present his/her findings to a board of experts and prepare a scientific publication of the results. Work on the thesis will be accompanied by regular attendance of seminars on the topic of research.
Study and exam requirements	<u>Master's thesis:</u> The master's thesis will be evaluated by the mentoring professor as well as by a second reviewer <u>Seminar on topics related to master's thesis:</u> After completing the master's thesis, students will hold an oral presentation on their work
Media used	Oral presentation, written thesis, digital projector, PowerPoint slides
Literature	Dependent on research project

BMSW14 – Lab automation and Project Management

Course of studies	Biomedical Sciences (MSc)						
Module	Technology Management						
Abbreviation	BMS14						
Course(s)	• Lab Automation • Project Management						
Semester	Winter						
Person responsible for the module	Prof. Dr. Jeannette Hübener Schmid						
Instructors	Prof. Dr. Jeannette Hübener-Schmid Dr. Nicolas Casadei						
Language	English and German						
Status within the curriculum	Elective module						
Type of course / WH	Course			L	E	LW	S
	Project Management			2			
	Lab Automation			2			
Workload in hours	Course	Class attendance	Study outside of class	Total		CP	
	Project Management	30	45	75			
	Lab Automation	30	45	75			
	Total	60	90	150		5	
Credit points	5						
Prerequisites for attending this course	none						
Recommended knowledge / course work	Successful students will obtain Project management • Basic understanding of project management						

Module goals / desired outcome	• Profound understanding of core project management principles to systematically plan, monitor, and control research projects within defined time and cost constraints • Ability to effectively apply budgeting, scheduling, and resource allocation techniques to ensure the economic feasibility of scientific projects • Competence in successfully leading, motivating, and organizing cross-functional or interdisciplinary research teams • Fundamental capability to identify, analyze, and mitigate potential project risks and manage stakeholder expectations efficiently Lab automation • Profound understanding of the core principles of automated high-throughput workflows in biomedical laboratories. • Profound understanding of sample identity tracking, fluidic systems, and spatial constraints in laboratory automation. • Fundamental understanding of data-driven process control and downstream data integration. • Comprehensive overview of the systems-thinking and documentation requirements needed to bridge flexible academic research with standardized, quality-managed diagnostic production. Skills: Social competence: Project management • Ability to effectively communicate project goals and progress to interdisciplinary team members • Ability to constructively collaborate within a team and manage stakeholder expectations • Ability to collaborate in interdisciplinary teams to define technical specifications for automated laboratory workflows.
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Content	Project management • Time and cost planning of projects • Risk management • Portfolio management • Scientific and financial evaluation of research projects • High-performance teams Lab automation • Laboratory management system (LMS) infrastructure • Liquid handling mechanics • Deck logistics and dynamic scripting • Automated data pipeline Integration, economics & compliance
Study and exam requirements	• Written examination (2h), presentation
Media used	Lecture, group work, interactive discussions, handouts, flipcharts
Literature	Tegally H, San JE, Giandhari J, de Oliveira T. Unlocking the efficiency of genomics laboratories with robotic liquid-handling. BMC Genomics. 2020;21(1):729. Published 2020 Oct 20. doi:10.1186/s12864-020-07137-1 Santacruz D, Enane FO, Fundel-Clemens K, et al. Automation of high-throughput mRNA-seq library preparation: a robust, hands-free and time efficient methodology. SLAS Discov. 2022;27(2):140-147. doi:10.1016/j.slasd.2022.01.002 Hess JF, Kohl TA, Kotrová M, et al. Library preparation for next generation sequencing: A review of automation strategies. Biotechnol Adv. 2020;41:107537. doi:10.1016/j.biotechadv.2020.107537

BMSW16: Internship semester (Add. Module only for stud. with 180 ECTS BSc's degree)

Course of studies	Biomedical Sciences (MSc)					
Module	Internship semester					
Abbreviation	BMSW14					
Course(s)	Internship semester					
Semester	Winter or Summer					
Person responsible for the module	Prof. Dr. Dr. Isabel Burghardt					
Instructor(s)	All instructors of faculty					
Language	English or German					
Status within the curriculum	Mandatory					
Type of course / WH	Course		L	E	LW	S
	Internship semester					
Workload in hours	Course	Class Attendance	Study outside of class		Total	CP
	Internship semester		900		900	30
Credit points	30					
Prerequisites for attending this course	See examination regulations					
Recommended knowledge / course work	Successful completion of semesters 1 and 2					
Module goals / desired outcome	After successful completion of this module: • Students have a profound insight into the structure, organization and operations of an industrial company or a research institution. (K2) • Students are aware of the independent processing of specific tasks within projects. (K2) • Students are able to determine the status of development / research by literature search. (K4)					

	• Students have acquired the skills for independent implementation of projects. (K4) • Students have gained the competence for a systematic and a structured approach. (K5) • Students have gained the competence to work scientifically. (K6) • Students have experienced the manners and practices in the work environment. (K2) • Students have improved their team and communication skills through participation in the working group. (K3) • Students interact successfully in intercultural surroundings. (K4)
Content	The internship semester is performed in close co-operation between the internship site, the student and the internship Office of the school of Life Sciences. In 24 weeks, interns work on projects in their industrial enterprises or their institutions, which are connected to the thematic study content of the curriculum.
Study and exam requirements	Continuous assessment, regular reporting, preparation of a project report manuscript, certificate of the internship site
Media used	
Literature	Depends on actual project