Biomedical Sciences

Diploma of Advanced Studies (DAS)

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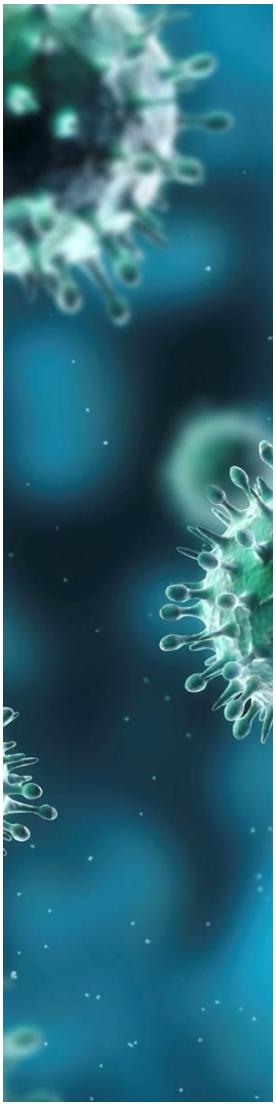

Module Handbook

April 2020

University of Freiburg

Prof. Dr. Dres. h.c. Christoph Borner

Institute of Molecular Medicine and Cell Research

in cooperation with

Freiburg Academy of Continuing Education (FRAUW)

CONTENT

1. Program

Biomedical Sciences combine the knowledge and questions of Experimental Medicine with the methods of Molecular Biology and Cell Biology. This international program is designed as an intensive time of studies and research with a specific and practical training that qualifies for success in academia or the private sector. IMBS modules treat the following topics: Pharmacology and Toxicology, Materials and Microsystems, Molecular Oncology and Cardiology, Immunology and Pathology, Molecular and Cellular Biology, Biostatistics and Bioethics.
In addition, participants can choose a personal research project. Each research project is individually supervised and involves eight weeks of lab work that is seven weeks of experimental work followed by a week of data analysis and a written lab report in the format of a scientific research publication.

The program is tailored to the interests of international graduate students with professional experience. Applicants should hold at least a Bachelor's degree or an equivalent degree in Life Science or Medicine or related fields[1].

2. Structure and Organisation

2.1. Responsible Persons

Scientific Director
Prof. Dr. Dres. h.c. Christoph Borner
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Coordinator and Consultant
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[1] Master, Diploma or other foreign degrees

2.2. Teaching Staff

The teaching staff is composed of professors and lecturers of the Albert Ludwigs University and the University Medical Center of Freiburg/Breisgau and from abroad.

IMBS Teachers of the University of Freiburg (ALU):

Teachers of the Faculty of Medicine

Prof. Dr. Dres. h.c. Christoph Borner
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Stefan-Meier-Str. 17, 79104 Freiburg
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Prof. Dr. Georg Alexander Häcker
Institute for Microbiology and Hygiene
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Teachers of the Faculty of Engineering

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Laboratory for Chemistry and Physics of Interfaces
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Prof. Dr. Jürgen Rühe
IMTEK, Department of Microsystems Engineering
Chemistry and Physics of Interfaces
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External teachers:

Dr. Felicitas Sofia Holzer
National Scientific and Technical Research Council of Argentina (CONICET)
Faculty of Philosophy and Lettres
University of Buenos Aires
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Dr. Ignacio Mastroleo
Researcher at the National Research Council of Argentina (CONICET)
Researcher at the Program of Bioethics FLACSO Argentina, Collaborative Center in Bioethics of the World Health Organization (WHO)
Chief of Lecturers in Ethics at University of Buenos Aires (UBA),
Faculty of Philosophy and Literature, Department of Philosophy
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Dr. Philippe Merz
Thales-Akademie für Wirtschaft und Philosophie, gGmbH
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Dr. Dr. Romina Zuppone
BIAP (Barcelona Institute for Analytic Philosophy) and Logos Research Group
Departament de Filosofia
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2.3. Methods of instruction and studying techniques

Language: English

Presence: Lectures, seminars and group work group
Presentations, journal clubs
Practical lab-work

Self Studies: Scientific reading
Preparation of presentations in groups
Preparation of intermediate exam
Practical lab work
Consolidation of acquired knowledge
Writing a lab report

2.4. Form and Length of the Program

2.4.1. Workload

The full length of the program is 6 months.
Please note, according to the intensive format of this fulltime program (Winter School) and in order to offer a highly flexible program, module sizes may differ from the usual extent. Modules of 2 CP, which is of 50 hours workload per week are offered as well as modules of 4 to 6 CP with the duration of 2 to 3 weeks of intensive course.
An additional workload is mentioned for times of preparation and study concerning participants from abroad within the IMBS Winter School Program (see 3.5).

2.4.2. Examinations and Grading

Examinations: Written or oral exams
Written lab reports

Final exam: Oral exam

Grading Scale:

GRADING SCALE		
	1,0 / 1,3	**excellent**
	1,7 / 2,0 / 2,3	**good**
	2,7 / 3,0 / 3,3	**satisfactory**
	3,7 / 4,0	**sufficient**
	5,0	**failed**

2.4.3. Degree and Credits

The program concludes either with a **Diploma of Advanced Studies "Biomedical Sciences" (DAS)** or with a **Certificate o f Advanced Studies (CAS) "Biomedical Sciences"** according to the workload and number of modules the student has chosen.

Diploma of Advanced Studies

For DAS a total of 30 credit points (CP) in the European Credit Transfer System (ECTS) is awarded.

Alternatively:

Certificate of Advanced Studies

For CAS a total of at least 10 credit points (CP) in the European Credit Transfer System (ECTS) is awarded.

Credit Points: Requirements

For being awarded credit points the following is required:

- preparation according to the specifications and material provided by the professors
- active participation in class
- reading and self-study
- active participation in group presentations
- successful written and oral examination

3. Overview of Modules

Nr	MODULES	Type of course	Credit points	Type of exam
	Intensive German Language Course	V+Ü	1	SL: written test
	Introduction into research methods and scientific communication	V+Ü+Pr	3	SL: oral presentation
I	Biostatistics (Ia) and Bioethics (Ib)	V+Ü+S	5	PL: written exam
II	Pharmacology and Toxicology (IIa), Materials and Microsystems (IIb)	V+S+Pr	5	PL: oral and written test
III	Molecular Oncology (IIIa) and Cardiology (IIIb)	V+S+Pr	5	SL: oral test PL: written exam
IV	Molecular and Cellular Biology (IVa), Immunology and Pathology (IVb)	V+S+Pr	5	PL: written exam
V	Labor Research (2 months)	Pr	6	SL: lab protocol PL: presentation
	Subtotal		**30**	

Type of course: V= lecture, S= Seminar, Ü= Exercise, PR= practical work
Credit points = ECTS: 1 credit point according to ECTS = 25 hours of workload
PL = Prüfungsleistung (grades included in final mark)
SL= Studienleistung (no grades, but has to be passed)

3.1. Intensive German Language Course

Lecturer	External company
Duration	Intense for 2 weeks, then regularly once a week for 27 weeks
Academic performance	Lectures, group work, practice with different media
Workload	**Total workload of 75h** ***Presence: 18,75 h/week during one month***
Credit points	1
Content	German Language training at Level A1 and A2 by using diverse communicative methods which are highly interactive and dynamic to suit different types of learners. The methods emphasize on listening & speaking skills, extension of vocabulary, the understanding and application of German grammar. Teaching material and content will additionally support the awareness, understanding and a good handling of the cultural diversity and the new environment.
Learning Outcomes	Students can demonstrate on Advanced Low level of Proficiency in German in speaking, writing, listening and reading ■ Speaking: students are able to handle a variety of communicative tasks. They are able to participate in most informal and some formal conversations on topics related to school, home, and leisure activities. They can also speak about some topics related to employment, current events, and matters of public and community interest. ■ Writing: students are able to meet basic work and/or academic writing needs. They demonstrate the ability to narrate, describe and express viewpoints about familiar topics in major time frames with some control of aspect.

	■ Listening and reading: students are able to understand short conventional narrative and descriptive texts (spoken and/or written) such as descriptions of persons, places, and things, and narrations about past, present, and future events with a clear underlying structure though their comprehension may be uneven. They can understand the main facts and some supporting details. Comprehension may often derive primarily from situational and subject-matter knowledge. ■ Students are able to communicate in Germany (and Switzerland and Austria) in order to organize their daily life and academic matters and are able to network
Exam	SL: Written test (which leads to a Certificate)

3.2. Introduction into research methods and scientific communication

Lecturer	External experts
Duration	Total of 1 week (introduction week) and then distributed over the time of the 8 months modules
Academic performance	Lectures, Courses, Training, Exercises, Self-Study, Preparation, practical work
Workload	Total workload of **125 h** **Introduction week: 50h and 75h during the 8 months** 40 h: Scientific writing, communication and presentation 50 h: Presentations – Work in progress including evaluation 20 h: Selfstudy and knowledge transfer 10 h: Intercultural training 5 h: Evaluation of the program
Credit points	3
Content	Intense training during the introduction week and then monthly meetings with presentations. **Scientific writing, communication and presentation:** Lectures and training about methods, resources, citation, publishing and structure of scientific papers, abstracts and master thesis. Lectures, group work and training in poster and oral presentations including standard rules and tools in design, presentation and writing, rhetorical skills, professional use of voice, facial expression, gestures and body postures. Learning through practice and group feedback. **Intercultural competence:** Lectures, group work and training in following topics: definition of culture, cultural models and cultural identity including foreignness and its impact. With awareness of the own cultural imprint the training will focus on stereotypes, prejudices and cultural dimensions. Understanding different communication techniques, verbal and non-verbal, the training will lead to strategies of successful cultural interaction including German historical and temporary facts as well as practical information about does and don’ts for living in Germany.
Learning Outcomes	**Scientific communication:** ■ Presentation of research projects orally, in writing, and as presentation ■ Label the components of a scientific paper and master thesis ■ Decide when it is appropriate to use the different types of scientific literature such as primary literature, reviews and textbooks ■ Identify thesis and development statements ■ Explain how scientific research is published (including the peer

	review process, open-access journals, and the embargo system) ■ Use online research tools (e.g. databases, e-journals, Google Scholar, Web of Science) to collect relevant information (e.g. scholarly articles, websites, blog posts) on a particular topic ■ Cite different types of scientific literature appropriately ■ Use an outline to organize a scientific argument with a claim and supporting evidence ■ Read scientific literature and assess the quality of the claims and evidence used to support them ■ Defend the validity of an argument by evaluating evidence in a variety of genres, including popular media, websites and scientific journals ■ Write an abstract by using the standard structure Write and present a presentation by using the state of art **Intercultural competence:** Students will demonstrate knowledge and understanding of other cultures and their products. By the time they graduate from our program, they will be able to: ■ Being aware of their own cultural imprint and its impact on their way of thinking and acting ■ Examine the validity of one's own cultural beliefs, behaviors and norms by contrasting and comparing them with those of the target culture ■ Recognize and describe the historical, social, economic, and political forces that shape society in the target culture ■ Understand and respect cultural diversity and its impact ■ Choose adequate techniques to handle cultural diversity in daily life e.g. perform change of perspective adequately or handle the feeling of foreignness ■ Communicate appropriate in an intercultural environment ■ Perceive and value cultural diversity and reinterpret the place of the self as an identity culturally situated in the global context
Exam	SL: Oral presentation

3.3. Biostatistics and Bioethics (Module I)

Module Ia	Biostatistics
Lecturers	Prof. Dr. Joschka Bödecker
Duration	7 days
Academic performance	Lectures, Exercises
Workload	Total workload of 63**h** ***Presence: 52,5h/ 7 days*** 5,5h/day: lectures 2 h/day: exercise ***Self-Study: 10,5h/ 7days*** 1,5 h/day: self-study, case-studies
Credit points	2,5
Content	The course will teach the following: • Introduction into the statistical software R • Descriptive statistics, colors and diagrams • Probability distributions • Point estimation and confidence intervals • Statistical tests, multiple testing • Introduction to Machine Learning • Linear methods for regression • Linear methods for classification
Learning Outcomes	■ Students know the difference between descriptive and inferential statistics ■ Students can perform a descriptive statistical analysis of their data ■ Students know the most important probability distributions for biomedical research ■ Students can apply important inferential statistical methods ■ Students will get familiar with an open source statistical software for biostatistics and machine learning, i.e. the package R ■ Students can train a model for linear regression and classification on their data ■ Students know how the results of their statistical analysis and trained machine learning model have to be interpreted
Recommended Literature	Main sources: ■ Kohl (2015). Introduction to statistical data analysis with R. bookboon.com. ■ Gareth, Witten, Hastie, Tibshirani (2013). An Introduction to Statistical Learning with Applications in R. Springer. Optional: ■ Dalgaard (2008). Introductory Statistics with R. 2nd edition. Springer. ■ Dancey, Reidy, Rowe (2012). Statistics for the Health Sciences. Sage. ■ Whitlock, Schluter (2015). The Analysis of Biological Data. 2nd edition. Roberts and Company Publishers.
Exam	PL: Written exam

Module Ib	Bioethics
Lecturers	Dr. Felicitas Holzer, Dr. Ignacio Mastroleo, Prof. Dr. Drs. em. Roland Mertelsmann, Dr. Philippe Merz, Dr. Romina Zuppone
Duration	1 week
Academic performance	Lectures, Seminars, Excercises
Workload	Total workload of **62,5 h** ***Presence: 50h/ week*** 4 h/day: exercises 3,5 h /day: lectures 2,5 h /day: discussions ***Self-Study: 12,5h/week*** 2,5 h/day: self-study, preparation presentation case-studies
Credit points	2,5
Content	Professors from Biology and Medicine but also from Philosophy, and Epistemology from ALU and UBA will give seminars and interactive workshops about Human Health and Research Ethics, Dignity, Ethics of Emergencies, Evidence Making in Science, Technology and Innovation Policy for an entire week. Given emerging global health crises and the rapid advances in biomedical technologies such as whole genome sequencing, organism cloning or the generation of inducible stem cells, future scientists will become increasingly exposed to bioethical issues. It is therefore crucial to discuss such issues with our master students as early as possible during their career path and provide them with the analytical skills to deal with.
Learning Outcomes	■ Students learn the importance of considering ethical aspects in biomedical sciences ■ Understanding the principles of bioethical research and its practical implementation
Exam	PL: Written exam

3.4. Pharmacology, Toxicology and Materials and Microsystems (Module II)

Module IIa	Pharmacology and Toxicology
Lecturers	Prof. Dr. Dr. Robert Grosse, Dr. Robert Mallmann
Duration	1 week
Academic performance	Lectures, Seminars, Practical Work
Workload	Total workload of **62,5h** ***Presence: 50 h/week*** 4 h/ day: Lectures and seminars 2 h/day: preparation of oral presentation 4 h/ day: practical course ***Self-Study: 12,5 h/week*** 2,5 h/day: self-study
Credit points	2,5

Content	The first part of this module offers basic and advanced knowledge about pharmacological studies of interaction between drugs (chemicals of synthetic or natural origin) and organisms (biological systems). Students will understand pharmacodynamic actions of drugs with a focus on drug-induced interaction with membrane receptors and subsequent signaling events. They obtain deeper insights into GPCR signaling as these receptors are responsible for most drug actions. Knowledge of the principles of structure and function of GTP-binding proteins (Rho-GTPases), will allow to understand their fundamental roles as general switch proteins in signaling and control of cytoskeletal dynamics. They will be able to integrate up-to-date views of structures, regulation and physiological functions of ion channels in a general concept of drug action. Principles of toxic effects (risks and hazards) and pathogenetic mechanisms of drugs will be delineated by presentation of various groups of bacterial protein toxins, which act with extremely high potency and efficiency on target cells and organs.
Learning Outcomes	■ Participants have knowledge of the mode of action of drugs and poisons, in order to allow a scientifically based, rational pharmacotherapy and treatment of poisoning. - Receptor tyrosine kinases - Bacterial toxins - GPCR Signaling - Voltage-gated ion channels - Rho-GTPases and cytoskeletal dynamics ■ Participants have the ability to get into specific topics of the field by reading current publications and to interpret and communicate the data, which should be applicable to other subjects in life science. ■ The students are able to design and perform experiments to unravel basic actions of drugs.
Literature	1. Selected parts of “Rang & Dale’s Pharmacology”, 8th edition 2. Aktories K. Bacterial protein toxins that modify host regulatory GTPases. Nat Rev Microbiol. 2011;9(7):487-98
Exam	PL: Oral and written exam

Module IIb	**Materials and Microsystems**
Lecturers	Prof. Dr. Jürgen Rühe, Dr. Oswald Prucker
Duration	1 week
Academic performance	Lectures, Seminars, Practical Work
Workload	Total workload of **62,5 h** ***Presence: 50 h/week*** 6 hrs/day: laboratory work 4 hrs/day: lectures ***Self-Study: 12,5 h/week*** 2,5 hrs/day: self-study (journal club work)
Credit points	2,5

Content	Special knowledge and state of the art methods for the generation, use and characterization of biomaterials are of great importance in Biomedical Sciences. For example, polymers are used for implants (heart valves, breast implants, artificial joints, retina implants) as well as for drug release or dental materials. Biointerfaces are also a key for the performance of bioanalytical devices (e.g. lab-on-disc or lab-on-CD devices). The lecture submodule will give the students a basic introduction into the field of biomaterials used in various biomedical applications and into methods used to characterize such materials. A special focus is placed on the use of polymeric materials in biomedical applications and on methods employed for the generation of tailor-made biointerfaces. The importance of surface interactions of biomolecules with surfaces in vivo and in vitro will be discussed. Additionally, models describing the interaction of biological cells with artificial materials will be presented. The laboratory submodule will explore 1) the generation and use of DNA-chips for the detection of bacteria 2) the measurement of protein adsorption to surfaces by surface plasmon spectroscopy. 3) Students will study cells on micro structured surfaces with the help of Atomic Force Microscopy (AFM) and they will learn how to probe surfaces with small tips. The literature submodule will consist of instructions on the performance of literature work. The CPI research lab organizes a journal club for all students to help them keep up with the literature produced by others who work in the biomaterial area. Taking part in the journal club helps participants to become familiar with the advanced literature and data in in the biomaterial area. This helps to rapidly improve the students' skills of understanding and debating current topics of active interest in this field.
Learning Outcomes	■ Students obtain basic knowledge about biomaterials and microsystems. ■ Students will obtain a basic understanding of the interaction of biomolecules with surfaces. ■ Students will gain an impression on the generation and use of selected, modern bioanalytical devices. ■ Students gain individual laboratory skills. ■ Students will become acquainted with the assessment and evaluation of scientific literature and also with interdisciplinary work.
Exam	PL: Oral and written exam

3.5. Molecular Oncology and Cardiology (Module III)

Module IIIa	Molecular Oncology
Lecturer	Prof. Dr. Ralph Wäsch
Duration	1 week
Academic performance	Lectures, Group Work, Exercises, Practical Work
Workload	Total workload of **62,5 h** ***Presence: 50 h/week*** 3 h/day: lecture 3 h/day: seminar 4 h/day: presentation ***Self-Study: 12,5 h/week*** 2,5 h/day: data analysis, documentation, and reading
Credit points	2,5
Content	Current selected topics in cancer research and diagnostic techniques: 1. Functional genetics using RNA interference and CRISPR/Cas in cancer 2. Cell cycle control in cancer and stem cells with a focus of the role of the ubiquitin-proteasome system on genomic instability of cancer cells, its function on differentiation in hematopoietic stem and progenitor cells and implications for therapy are discussed. 3. Modeling acute leukemias in mice to gain biology insights for human disease. 4. Molecular Diagnostics in Hematology/Oncology including a current overview of the most important molecular diagnostic methods with the focus on PCR and sequencing technologies. Important molecular markers in hematology and the necessity and technique of cell selection is discussed. In a second, practical part the students learn how to perform essential techniques. 5. Flow Cytometry: This course is designed to familiarize students with the basic principles of flow cytometry. Students will learn the technical principles behind flow cytometry, as well as how to apply them at both the theoretical and practical levels. The morning session consists of a lecture and the afternoon includes a practical session showing basic usage of flow cytometry in an example experiment.
Learning Outcomes	■ Basic concepts and techniques in the field of molecular biology of cancer are understood. ■ Participants have the ability to get into specific topics of the field by reading current publications and to interpret and communicate the data, which should be applicable to other subjects in life science. ■ The lectures impart on principles of personalized cancer medicine by understanding targetable individual cellular aberrations in selected malignant neoplasms, which is key in current oncology. ■ The practical application of important techniques for the diagnosis and evaluation of treatment outcome of cancers will be learned.
Exam	SL: Oral test PL: Written exam

Module IIIb	Molecular Cardiology
Lecturers	PD Dr. Dennis Wolf, PD Dr. Peter Stachon, Dr. Julian Merz
Duration	1,5 week / 8 days
Academic performance	Lectures, Seminars, Practical work
Workload	**Total workload of 62,5 h** ***Presence: 50 h/8 days*** 20 h in total: lecture 8 h in total: seminar 20h in total: practical course 1h: written exam ***Self-Study and guided analysis: 13,5 h/8 days*** data analysis, documentation, and reading
Creditpoints	2.5
Content	This module is focusing on recent key aspects of translational research in cellular and molecular cardiology. The participants will learn about basic immunologic and inflammatory mechanisms promoting atherosclerosis, myocardial infarction, and the metabolic syndrome as well as about the fundamental processes governing cardiac metabolism and dysfunction. They will practice standard techniques of molecular biology and physiology related to cardiovascular disease. Additionally, they will analyze, critically discuss and present current experimental as well as clinically related publications in the context of cardiovascular diseases.
Learning Outcomes	■ Participants define and describe underlying mechanisms of cardiovascular disease focusing on inflammatory and immune mechanisms in atherosclerosis, myocardial infarction, and the metabolic syndrome, as well as cellular and energetics-related mechanisms of heart failure. ■ Participants perform and interpret results of state-of-the art techniques of molecular biology and physiology related to cardiovascular disease research
Exam	SL: Oral test PL: Written exam

3.6. Molecular and Cellular Biology, Immunology and Pathology (Module IV)

Module IVa	Molecular and Cellular Biology
Lecturers	Prof. Dr. Dres. h.c. Christoph Borner, Prof. Dr. Georg Alexander Häcker
Duration	1,5 week / 8 days
Academic performance	Lectures, Seminars, Practical Work
Workload	**Total workload of 62,5 h** ***Presence: 50 h/8 days*** 2 h in total: lecture 3,5 h in total: seminar 45h in total: practical course 2h: written exam ***Self-Study and guided analysis: 10 h/8 days*** data analysis, documentation, and reading
Credit points	2,5
Content	In this module a variety of biochemical and cellular tools and methods will be used to quantify apoptosis in eukaryotic cells by various biochemical and cellular methods. The goal is to get experienced with culturing, handling and counting both suspension and adherent mouse cells, to induce apoptosis either by growth factor deprivation or genotoxic stress, to prepare a cell extract, to measure protein content and caspase-3 activity in an fluorescent-based enzymatic assay and to determine the levels of active caspase-3 and members of the Bcl-2 family by Western blotting. In addition, cells are subjected to flow cytometry analysis (FACS) to determine the proportion of apoptotic cells, which have phosphatidylserine exposed on the surface (detected with FITC-Annexin-V) and necrotic cells, which have a permeabilized plasma membrane and therefore allow the entry of the red fluorescent dye propidium iodide. Finally, the students learn to fix cells on coverslips, incubate them with various primary and secondary fluorescent labeled antibodies and perform an immunofluorescence analysis to determine the amount and subcellular localization of Bcl-2 family proteins and cytochrome c (which is retained in mitochondria in healthy cells and released into the cytoplasm in apoptotic cells). In this way they learn to properly handle a fluorescent microscope and to use photo capturing and the software to produce nice fluorescence pictures of eukaryotic cells. The students are organized into working groups of 3 to max 4 people, but each student performs the experiments with his/her own hand. This course is therefore a really HANDS-ON practice module. Each group is supervised by a senior PhD student or postdoc who assists them with the practical work, gives advice and introduces each method in the form of a seminar. The students also learn to critically and statistically analyze their data and to write a scientific lab report with the data obtained, which will be critically evaluated by the supervisors. If not satisfactory, the reports have to be corrected (Studienleistung).

Learning Outcomes	At the end of the Module the students have: ■ Knowledge of cellular and biochemical methods on eukaryotic cells ■ Knowledge of rules and safety measures of genetically modified organisms and hazardous substances and the ability to work accurately under sterile conditions ■ Statistical analysis of the data ■ Proper logging and lab reporting
Exam	PL: Written exam

Module IVb	**Immunology and Pathology**
Lecturers	Prof. Dr. Oliver Schilling, Dr. Melanie Föll
Duration	1 week
Academic performance	Lectures, seminars, laboratory work, computer work
Workload	**Total workload of 62,5 h** ***Presence: 45 h/week*** 5 h/day: lectures, seminars 2 h/day: laboratory work 1 h/day: computer work ***Study: 12,5 h/week*** 1 h/day: reading, data analysis and documentation
Credit points	2,5
Content	This module contains two submodules: Immunology and Molecular Pathology. "Immunology" comprises lectures on topics in graft versus host disease, immune cell types, tumor immunology, genetic immunodeficiency diseases, allogenic transplantation, microglia, and dermatitis. The submodule pathology will demonstrate methods and essentials in histopathology, biobanking, and genomics in molecular pathology. Further topics cover mass spectrometry-based proteomics and metabolomics. The laboratory practical training covers immunohistochemistry and mass spectrometry-based proteomics together with an introduction to MALDI imaging. The informatics session introduces digital, quantitative pathology and bioimage analysis
Learning Outcomes	Participants will get an overview of the following topics: ■ Understanding the role of different components of the immune system in human disease. ■ HLA System class I and class II ■ Human natural killer cells: NK receptors, role in tumor defense and stem cell transplantation. NK education ■ Human γδT-cells: Subsets, Molecular Biology and role *in vivo* ■ TCR and Ig: Composition and function ■ Primary and secondary immunodeficiencies ■ Malignant Lymphomas ■ Acute and chronic Leukemias ■ Hematopoetic cell transplantation: Immunological aspects ■ Tumor immunology ■ Histology ■ Proteomics ■ Metabolomics ■ Digital pathology
Exam	PL: Written exam

3.7. Laboratory Research (Module V)

Module V	Laboratory Research
Lecturers	All Faculty at ALU
Duration	2 months (8 weeks)
Academic performance	Practical Work and Self Study
Workload	**Total workload of 160 h** ***Presence: 20 h/week*** 20 h/week: Laboratory work including documentation
Credit points	6
Content	Laboratory Research includes an intensive period of experimental laboratory work including documentation, self-study and discussion about methods and results. Participants choose from the participating faculties either one lab for eight weeks, or two labs for four weeks each, where they experimentally work on a defined research project to get data, which are then analyzed and documented and finally presented in the form of a 30 min oral seminar. The goal of this module is to learn as many techniques and methods possible, to accurately mine data at the bench using the right controls and a correct statistical analysis, to critically assess own data and the data of their lab mates, to participate in lab seminars to discuss science, to read and present the relevant literature and present the progress of the laboratory research in seminars in front of the research group or the institute. In most cases the research topic is continued in the same lab(s) for the subsequent master thesis. However, the students can change the topic and/or the research lab after the lab research and start with something entirely new for the master thesis.
Learning Outcomes	■ Participants learn in-depth about methods and documentation during hands-on ■ They should be able to adapt methods to specific questions ■ They understand all principles of laboratory work in the chosen laboratory/laboratories
Exam	SL: lab protocol PL: Oral presentation