12 / 2024

Biochemistry

Master of Science

EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Welcome

Welcome to the University of Tübingen and welcome to its Interfaculty Institute of Biochemistry, IFIB for short. Thank you for choosing this course and congratulations on passing the competitive selection process.

You are now at the second stage of your university education. A period to discover and develop your preferences in the field. And only one step away from your second major professional decision after deciding what to study. At the end of the Master, you will choose whether to continue along the academic track with a doctorate or whether to enter the job market. We strive to support you with this important decision.

You are also no longer a beginner in the field and we believe the structure of the master's degree should strongly reflect this and support your further maturation towards a full-fledged biochemist. In our course, this shows in the small number of obligatory elements and the large number of choices you can make. On the other hand, you have to invest more time making decisions and organizing yourself. It also shows in that a significant part of the degree will be dedicated to preparing you for future career decisions with seminars and transferable skill courses.

We are looking forward to working with you and wish you all the best for the start of your master's here in Tübingen.

Gabriele Dodt, Dean of Studies

Ralf-Peter Jansen, Head of Examination Board

Markus Wolters, Study coordinator

cover picture: albarst

Gerhard Groebe

Overview

The Tübingen *Master of Biochemistry* is a full-time 2-year program composed of 5 types of modules (see table below). Students have to earn a minimum of 120 credit points in total, each of which corresponds to approximately 30 hours of work including self-directed study. All 4 elements are explained in detail later in the guide. *Advanced Biochemistry* and *Current Topics* are theoretical modules while *courses*, *labs*, and the master thesis are combined theoretical and practical elements.

Modules of the Master	Credit points
Advanced Biochemistry	9
Current Topics	3
3x Courses	3x 6
4x Labs	4x 15
Master thesis	30
	120

The Tübingen *Master of Biochemistry* gives you a high level of flexibility. You do not have to take all the modules in a specific order or at a specific time. Nevertheless, we recommend organizing your degree roughly according to the order above. The theoretical elements are a good starting point to gain an overview of the fast-moving field of biochemistry and are thus well placed at the beginning. They may also serve as preparation for the laboratory work later on. *Courses* are designed to be a transition from theory to more practical work, since they contain both the background as well as the corresponding guided experiments. It is also a good way of getting to know your peers. *Labs* require more organization from your part and are your stepping stone from pre-designed courses to the more independent master thesis that concludes the *Master of Biochemistry*.

Aims

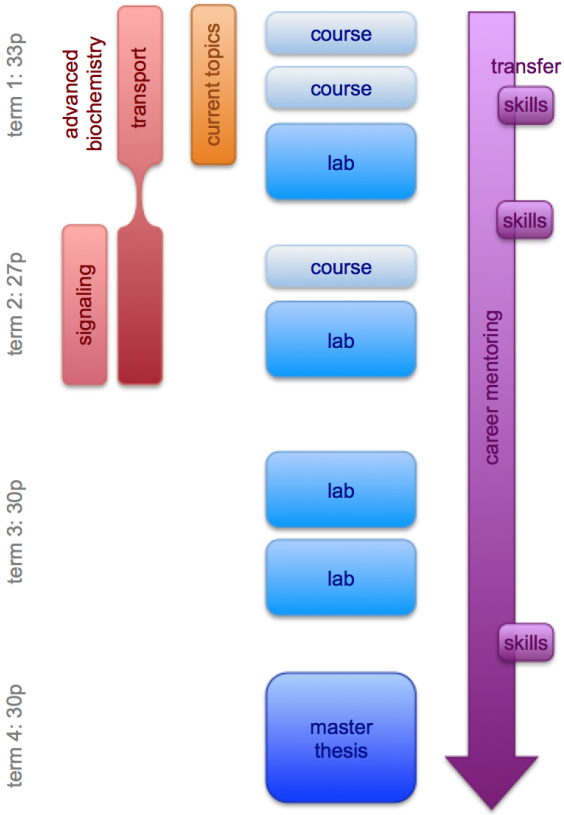
Upon completion of the Master of Biochemistry in Tübingen, you will have gained significant lab experience in diverse areas of life science, mainly via 4 lab rotations and your master thesis. This will enable you to make a well-informed choice regarding your future career, in research or elsewhere. In contrast to fast-track programs, you will know and be able to compare several research areas to pick the one that suits you the most for a PhD for example.

In addition to having honed your lab skills, you will have deepened and broadened your understanding of the biochemical basis of life and disease. This new knowledge will stem from the advanced lecture series, the course seminars, and your lab rotations.

Besides biochemical practice and theory, you will have improved 3 transfer skills: presenting, writing, and organization. You will get qualified feedback on your presentation and writing skills during all modules. It's up to you to decide to take optional skill courses to improve the above. 5 lab projects in total will increase your capacity to organize and exert your work.

A Master Plan

This page shows you one possible and straightforward way to complete the *Master of Biochemistry*. Many variations on this theme are possible and depend on your individual preferences.



Year 1 - Intro, Courses, First Labs

The 1st year kicks off with a joint lectures series by all the research group leaders of the institute. Departing from the basics you have acquired in your previous degree, this series takes you into the advanced topics of biochemistry and to the research frontier. In parallel, you will choose your first *modules* and your first *lab* placements.

In parallel to the lecture series, you will take a course on current topics, which includes a lecture series by guest speakers from outside the institute and abroad presenting their latest discoveries. In addition, you will most likely select a 3rd module and a 2nd lab placement.

Year 2 - Course, Labs & Master Project

As you enter the 2nd year, the elements of the program will become longer and more in-depth culminating in the master thesis at the end of the degree. You may decide to do one or more of the research placements outside the institute or abroad. We will support you with national and international placement using our contacts. At the end of the last semester, you will write up the data collected during your thesis and present the results to the faculty.

During the entire degree you will be able to acquire transferable skills ranging from numerical proficiency, IT, self-management and communication to interpersonal skills (purple track above). The IFIB faculty will support you in your future professional decision following your master in Tübingen.

Requirements

Please refer to our webpage (https://www.ifib.uni-tuebingen.de/studium/master.html) for details on our entrance requirements. In short, you need to have a bachelor in a related life science with excellent results, in-depth lab experience, and fluency in English (equivalent to at least C1 or proficient user). You should have asked a novel research question, chosen and executed appropriate experiments, and critically evaluated the results, most commonly in your bachelor thesis. You should be self-motivated, driven, and curious.

Variety

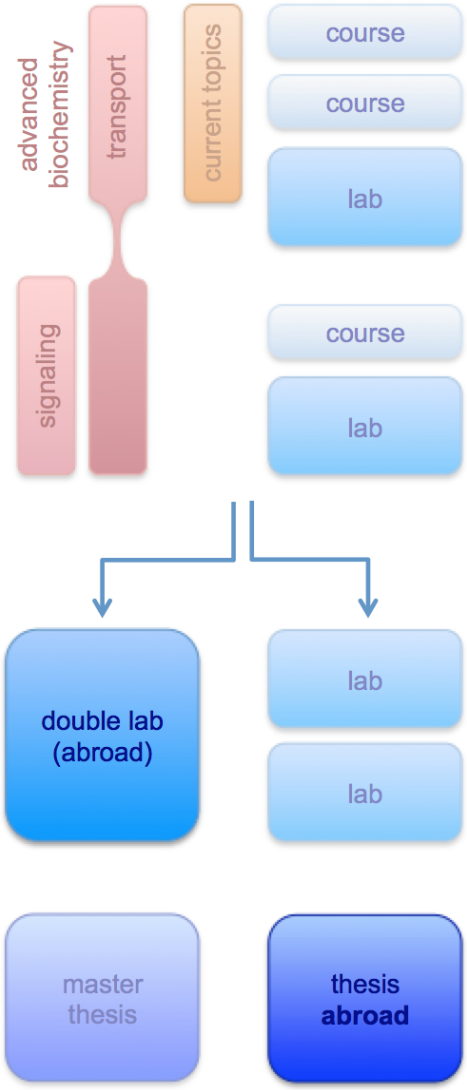
Here are a few ideas on how to adapt the template presented on the previous page to your personal preferences. Many variations are possible. Please discuss them with us.

In case you want to delve deeper into a special topic or in case you think one lab block is not enough to gain all the experience you want, you can fuse 2 *lab* blocks into 1 continuous element accounting for 2x15 credits. Do not chunk together more than 2 labs to make sure that you also see a variety of research topics.

If you want to do one of your *labs* abroad, a double lab may be useful. It takes time to organize a stint in another country. To go through all this work for a single lab element may not be efficient for you. Furthermore, the receiving group leader may be more willing to accommodate you, if you stay longer.

Another possibility to gain international experience is to do your master thesis abroad. This element of the master's degree is naturally longer, thus the ratio of preparation and lab time is better than for a single lab. On the other hand, it is an element that impacts on your final grade, so you need to be more carefully to select a good lab and a sure project.

In principle you can also take the *Advanced Biochemistry* lectures and the current topics during different semesters. However, we recommend starting early.



Advanced Biochemistry

The lecture series *Advanced Biochemistry*, nicknamed ABC, picks up where you left off with the basic lecture series of the bachelor degree and takes you farther into the advanced research topics. Reflecting this, the study material will be more papers and less textbooks, and the hypotheses will be more controversial and less established.

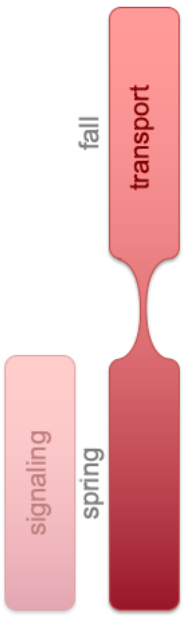
This module of the master is composed of 2 parts: transport and signaling. The transport series runs during 2 terms (winter + summer) while the signaling lectures are all in the summer semester. It complements the practical training that you will receive via *Courses* (also called *Modules*) and *Labs* (aka *Lab rotations*).

Advanced Biochemistry is a relay of all the lecturers of the Biochemistry institute. Every person has a block of consecutive presentations and then hands over to a colleague. This will give you the chance to get to know the entire faculty of biochemistry and experience their distinct research angles.

Element Overview

Goals	You acquire cutting-edge knowledge of the biochemistry governing cellular dynamics and communication. You critically evaluate recent discoveries.
Content	Extracellular matrix, cellular attachment, pathogen receptors, cellular uptake processes, endocytosis, endosomal escape mechanisms, targeting/transport in cells, organelle structure and maintenance, cytoskeleton, motor proteins, signaling pathways, oncobiology, hormones
Format	• Cellular transport processes (2 hours/week in winter and 2 in summer term) • Signal transduction (2 hours/week in summer term)
Duration	2 semesters in total (3x 1 semester series)
Recommended semester	• Cellular transport processes: 1st + 2nd semester • Signal transduction: 1st or 2nd semester
Frequency	Each lecture is offered once per year
Participants	6-30
Evaluation	Oral examination with 2 professors or lecturers, at least one from the IFIB or biochemistry section of the ZMBP about both lectures, 45 min/student
Responsible	Dean of Studies in Biochemistry
Organizers	Professors / lecturers of the IFIB and the ZMBP
Work load	90 h contact time + 180 h self-directed study
Credit points	9 CP

Transport - Advanced Biochemistry



Rapaport	lipids, transmembrane transport
Schaeffer	biophysics of molecular motors
Dodt	membrane dynamics, vesicle transport
Schwarzer	transport visualization nuclear import drug delivery
Jansen	cytoskeleton / motors mitosis
Stehle	virus entry glycosylation

The approximate overview of topics is indicated in the graph. Each lecturer is responsible for their block of presentations, typically taking place every Tuesday morning.

The biochemical basics of cellular transport processes will be reviewed before proceeding to the topical research questions and debates of the field.

Unless you have started in summer, we recommend to take the winter semester lectures first, as it is partly the basis for later lectures but the order can also be reversed.

Details regarding the individual lectures and teaching material will be made available and updated on the learning platform ILIAS.

Signaling - Advanced Biochemistry

Schulze-Osthoff	signaling in apoptosis and cancer
Feil	cardiovascular signaling
Stafforst	immunity signaling

In summer, in parallel to the 2nd part of the transport lectures, there is an additional series on the biochemistry of signaling processes.

In it you will get to know the remaining group leaders of the IFIB.

Signaling is a cutting-edge field involved in most aspects of biochemistry. We chose the topic partly because of the specialties of the in-house group leaders and because of its central importance. Together with transport they both represent very active areas of biochemical research. We hope you will enjoy our lectures and are looking forward to your feedback.

Examination

Advanced Biochemistry is one of the graded elements of the *Master of Biochemistry*. After you have completed the series, there will be an approximately 45 minute oral examination by 2 lecturers on general biochemistry, the lecture series, and 3 external speakers of your choosing.

See https://uni-tuebingen.de/de/46394.

Current Topics in Biochemistry

Biochemistry is a fast-moving field, which is why we want to dedicate an entire element of the master's course to topical issues. Also, as master students you have already gained a lot of experience, so we want to approach the material in a more collegial format rather than a typical frontal lecture.

Goals	You critically summarize and present a recent technology / discovery. You give constructive feedback to improve the work of your peers.
Content	Current findings, problems, and debates in biochemistry Modern experimental approaches
Format	Various interactive seminars and presentations
Duration	1 term
Recommended semester	1st or 2nd term
Frequency	10-12 invited speakers (typically Mondays) per term Weekly Current topic seminars every winter term
Evaluation	Participation and attendance during 1 term (not graded) Your presentation will receive a score for your orientation.
Responsible	IFIB lecturers
Work load	30 h seminars + 60 h preparation / research
Credit points	3 CP

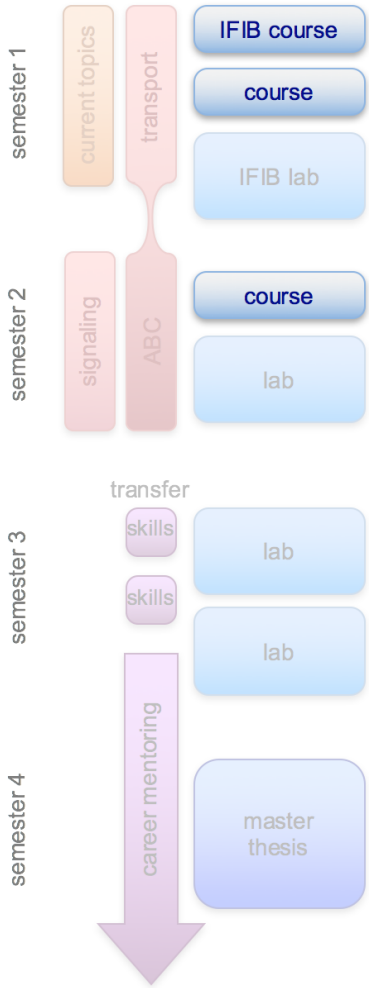
It is part of Current Topics to attend and participate in at least 20 of the weekly institute seminars. Every Monday during term time lecturers and students of the institute invite top class researchers from Germany and abroad to tell us about their recent discoveries. Attendance will give you an impression of current research, be an opportunity to ask questions, and find a lab rotation.

Courses

Courses are intended as both a transition from large-scale practical courses to independent research and as a way to connect with your classmates and build your network. In contrast, during the *Labs* you will rarely coincide with other master students. *Courses* last about a month and consist of about 90 hours of contact time plus 90h of self-directed study. They typically consist of a theoretical part in the form of lectures and seminars and a practical part. Most are evaluated by a combination of a protocol and an oral examination. You will select a total of at least 3 *courses* and receive 6 credit points for each successfully completed one.

IFIB Courses (at least 1 from this pool)

- Cell biochemistry of organelles (Rapaport & Dodt)
- Cell signaling (Feil)
- Chemical biology (Schwarzer & Stafforst)
- Genetic engineering (Gust, Fuß)
- Molecular oncology (Schulze-Osthoff)
- Post-transcriptional control / RNA (Jansen & Stafforst)
- Structural biology (Hartmann)
- Microscopic imaging techniques (Wolters, Richter, Feldhaus)
- Epigenetics and gene regulation in infection biology (Filarsky)



Courses from contributing investigators

- Imaging from probe development to in vivo application
- Cell biochemistry with fluorescent fusion proteins (Rothbauer)
- Immunology (Weber & colleagues)
- Advanced Infection Biology (Wagner)
- Imaging from probe development to in vivo application (Maurer)
- Osteogenesis and wound closure (Ehnert, Nüssler)
- Pathobiochemistry (Weigert)
- From Gene to Probe: Generation, Profiling and Application of Chemical Probes (Gehringer)

Apart from the requirement of at least 1 IFIB *course*, you are completely free to choose according to your personal preferences and aims. You could, for example, focus on medical topics like oncology, pharmacology and pathobiochemistry. Or you could hone your technical skills with bioinformatics, microscopy, and biochemical techniques. It's up to you. You can also take more than 3 courses if free places are available.

Courses are evaluated combining different aspects of the work done. Many will take into account your lab protocol, have an exam to gauge your grasp of the underlying theory, and evaluate your participation and lab work.

Timing of Modules

In designing the master degree we had to choose between unavoidable trade-offs. On the one hand, a master with smoothly timed but compulsory elements. On the other hand, a master that gives you choice but where timing problems may occur. We favor the latter since it is important that you can develop your own personal profile and since we believe you are capable of organizing yourself at the master stage.

The screenshots above are from the *Master Calendar* (http://tinyurl.com/mbioch-cal) or go to the IFIB webpage under Master, subpage Links. Please refer to it when choosing your *courses*. You can also subscribe to it depending on your local calendar software. Some are offered both in winter and summer to allow you to minimize overlaps. Most of them have no additional requirements and finish within a 4 week window. Please check the course description below since a few deviate.

Let us know which *courses* you would like to have added and who may offer it. We will try our best to convince the group leader(s) in question to invest the time to develop a course.

A list of all the current *courses* follows below. Each also has a page with details on the learning platform *ILIAS* (https://ovidius.uni-tuebingen.de/ilias3/) which you can access once formally signed up as a student.

IFIB Course: Cell Biochemistry of Organelles (BCH-5500)

Goals	Experience in handling of cell cultures and yeast including principles of subcellular fractionation of organelles; design and evaluation of experiments for quantitative measurement of RNAi; experience in fluorescence microscopy of mitochondria and peroxisomes; critical presentation and discussion of data
Content	Topics: mitochondrial biogenesis and morphology; peroxisome dynamics and function Methods: subcellular fractionation, fluorescence microscopy, native gel electrophoresis, transfection of cell cultures, RNAi, quantitative RT-PCR, yeast genetics
Format	Lecture, seminar, practical course
Frequency	Summer term
Participants	4-12
Evaluation	Audited protocol (not graded) Oral presentation of the results and oral examination (=> grade)
Organizers	Doron Rapaport, Gabriele Dodt

IFIB Course: Cell Signaling (BCH-5570)

Goals	Understanding of selected signal transduction modules that are important for cardiovascular function in mammals Evaluation of the relevance of biochemical research to improve our understanding of human health and disease Getting experience in handling and analysis of mammalian cells and stem cells in particular Design and performance of well-controlled experiments; documentation and interpretation of data; critical presentation and discussion of data
Content	Topics: signal transduction in mammalian cells, with a focus on the cardiovascular system; visualization of signaling molecules in real time in living cells; cell death and survival; transgenic mice as models for human diseases; stem cell biology; regenerative medicine Methods: biochemical analysis of signaling proteins; live cell imaging (e.g. with FRET-based biosensors); analysis of gene expression (e.g. immunohistochemistry on mouse tissue sections); cell growth assays; generation of genetically-modified mice; Cre/lox recombination system; culture of mammalian cells, in particular stem cell culture and differentiation; iPS cell technology
Format	Lecture/seminar, final seminar Practical course
Frequency	Summer term
Participants	4-8
Evaluation	Protocol (graded, 25%) Performance at work (graded, 25%) Oral examination (graded, 50%)
Organizers	Robert Feil, Susanne Feil, Hannes Schmidt

IFIB Course: Chemical Biology (BCH-5560)

Goals	Exercise in advanced solid-phase peptide chemistry. Handling and synthesis of building blocks for solid-phase peptide synthesis. Application of chemoselective reactions for protein engineering. Development of strategies for protein semisynthesis.
Content	Topics: posttranslational modifications of proteins, chemical labeling of proteins, protein chemistry Methods: solid-phase peptide synthesis, organic chemistry, protein semi-synthesis, methods for purification and analyses of semisynthetic proteins
Format	Lecture, seminar, practical course
Frequency	Summer term (from summer 2024 onwards)
Participants	2-8
Evaluation	Protocol (10-15 pages including introduction, results and discussion) 50% Oral examination (20 minutes) 50%
organizer	Dirk Schwarzer, Thorsten Stafforst

IFIB Course: Modern Genetic Engineering (BCH-1290)

Goals	Overview of the most important methods of modern genetic engineering and their application in plants
Content	Methods applied: PCR mutagenesis, Gateway cloning, DNA sequencing, transient protein expression, transformation and PCR analysis, synthetic gene design Methods discussed: generation of genetically modified organisms, virus-induced gene silencing, amiRNA technology, TALEN, lambda-red
Format	Lectures, seminar, practical course
Frequency	Winter term
Participants	0-6 (together with 10 BSc students)
Evaluation	Lab book (50% of final grade) Presentation of results (50% of final grade)
Organizers	Andrea Gust, Elisabeth Fuß

~~IFIB Course: Molecular Oncology (BCH-5520)~~ not offered currently

Goals	Understanding of the major signaling pathways that promote carcinogenesis and therapy resistance Understanding of the major metabolic alterations in tumor cells Understanding of the concept of cancer stem cells Obtain insights in novel tumor therapies and conduct of clinical trials Design and performance of well-controlled experiments; documentation and interpretation of data; critical presentation and discussion of data
Content	Topics: Principles of tumor biology; oncogenes and tumor suppressor genes; cancer epigenetics; control of cell death and survival; apoptosis and senescence; induced pluripotent and cancer stem cells, tumor metabolism; translational oncology and personalized medicine; molecular targeted cancer therapies, tumor immunotherapies.

	Methods: biochemical analysis of signaling pathways; live cell imaging; immunocytochemistry; kinase assays; immunoprecipitation; flow cytometry; analysis of gene expression; assays for detection of apoptosis and senescence, cell cycle analysis; culture of mammalian cells, in particular stem cells; iPS cell technology
Format	Seminar, final seminar, practical course
Frequency	Between winter and summer term
Participants	4-12
Evaluation	Lab protocol (1/3 of final grade) Performance at work (1/3 of final grade) oral exam (1/3 of final grade)
Organizers	Klaus Schulze-Osthoff

IFIB Course: Posttranscriptional Control of Gene Expression (BCH-5510)

Goals	Experience in handling of RNA; design and evaluation of experiments for quantitative measurement of RNA and proteins; design of control experiments for quantitative measurements; critical presentation and discussion of data
Content	Topics: mRNA stability; translation and its control; RNA-binding proteins Methods: Northern blot; qRT-PCR; quantitative Western blot; RNP purification; ribosome binding assays
Format	Lecture, seminar, practical course
Frequency	Winter term
Participants	4-8
Evaluation	Audited protocol (not graded) Oral presentation of the results (not graded) Oral examination (=> grade)
organizer	Ralf-Peter Jansen, Thorsten Stafforst

IFIB Course: Structural Biology (BCH-5530)

Goals	Understand the general flow of a structural analysis, practice of different methods of crystallography (SAD, MR), evaluation of published data (significance, quality)
Content	Topics: Practical aspects of structure determination using modern X-ray crystallographic methods. Students will be trained to solve structures and interpret their validity. As part of the module the students will learn how to crystallize proteins and solve the phase problem by Sulfur-SAD using lysozyme as a model system. Structure refinement against the experimental data and validation of the structure model will finalize the exercise. Methods: X-ray crystallography
Format	Lecture/seminar, practical course
Frequency	Winter term
Participants	10
Evaluation	Oral examination (⇒ grade)

Organizers	Dr. Georg Zocher; Prof. Marcus Hartmann

IFIB Course: Epigenetics and gene regulation in infection biology (BCH-5640)

Goals	Advanced understanding of the basic principles underlying epigenetics and gene regulation in eukaryotic organisms, with an additional focus of their relevance in the context of infection biology. Gain insights in state-of-the-art methodology to investigate epigenetics and chromatin biology. Design conduct and control complex molecular and cell biology experiments. Critical presentation and discussion of experimental data.
Content	Topics: Apicomplexan parasites with a focus on the malaria causing parasite Plasmodium falciparum. Genome editing. Epigenetics and chromatin biology. Non-coding RNAs. Methods: Molecular cloning; CRISPR/Cas9 gene editing; Western blot; P. falciparum cell culture; Parasite growth assays; Flow cytometry; Fluorescence microscopy; Protein co-localization studies
Format	Lecture / Seminar / Practical course
Frequency	Summer term
Participants	4-6
Evaluation	Performance during the course (25%) Project/Seminar presentation with discussion (75%) Audited protocol (required to pass)
Organizers	Prof. Dr. Michael Filarsky

"Cross-Campus" Course: Microscopic Imaging Techniques (BCH-5590)

NOTE: This is an intensive course with work on weekends!

Goals	Selection of an appropriate imaging technique and reliability to use it Evaluation of quality and validity of published data
Content	Detailed theoretical and practical knowledge of microscopic techniques (wide field, fluorescence, life cell, confocal microscopy) Sample preparation, selection of the conditions to get and process an image are taught and trained as well The seminar gives an insight into newly developed imaging techniques.
Format	Lecture/seminar, practical course
Frequency	Summer term
Participants	4-8
Evaluation	Seminar presentation (25%), Protocol (25%), Project presentation (50%)
Organizers	Christian Feldhaus; Sandra Richter; Markus Wolters

External Course: Modulating osteogenesis and wound closure *in vitro* (BCH-5600)

Goals	Experience in handling of cell cultures (isolation, expansion and differentiation of primary human osteoblasts)

	Design and evaluation of experiments for determining the effect of biological substances/epigenetic drugs on osteoblast growth and function Team work (groups of 2) Presentation and discussion of the experimental results in English
Content	Topic: Evaluating the effect of various biological substances/ epigenetic drugs on osteoblast growth and function (osteogenesis) Methods: Isolation and culture of primary human osteoblasts, viability tests, proliferation measurement, enzyme activity measurement, histological stainings (e.g. matrix mineralization), scratch assay for measuring wound closure
Format	Lecture/seminar, practical course
Frequency	Each term
Participants	2-4
Evaluation	Written summary (2-5 pages) incl. materials, methods & results (30%) Performance at work (30% of final grade) Talk/poster presentation (40%)
Organizers	Dr. Sabrina Ehnert, Prof. Andreas Nüssler

External Course: Cell Biochemistry with Fluorescent Fusion Proteins (BCH-5580)

Goals	One of the major challenges in cell biology is to understand cellular processes in response to external stimuli. The main goal is to localize cellular components and understand their interactions. Fluorescent fusion proteins are key factors to study the cellular distribution and dynamics of proteins in living cells using time lapse analysis and High-Content Analysis based on automated microscopy. To develop cellular models for compound or siRNA screening, fluorescent fusion proteins have to be generated and expression of fluorescent fusion proteins has to be validated in a number of disease relevant cell lines.
Content	In this course students will learn different aspects on how to generate fluorescent fusion proteins in appropriate vector systems (PCR, cloning, sequence analysis) as well as how to use them in various cellular and biochemical assays (cell proliferation, immunoprecipitation, Western blotting). You will learn cultivation of various human cell lines (sterile cell culture), different techniques to transfect/transduce human cell lines with expression vectors and how to analyze transfected cells on molecular and biochemical level. Students will have access to various imaging techniques including live cell analysis and immunofluorescence.
Format	Practical course, seminar
Frequency	Each term
Participants	2-4
Evaluation	Oral presentation at the start (1/3 of grade) Audited protocol (1/3 of grade) Oral examination (1/3 of grade)
Organizers	Prof. Dr. Rothbauer

External Course: Imaging from probe development to in vivo application (BCH-5610)

Goals	Participants will gain a solid theoretical and practical foundation in clinically relevant imaging techniques like positron emission tomography, magnetic resonance, and computer tomography.
Content	The module deals with the radiochemistry of imaging probes (50%) and with their in vivo detection (50%). Participants will synthesize precursors for radiolabeling, learn how to radiolabel, and finally apply these imaging probes in small live laboratory animals. The module also involves detailed data analysis. Methods: Organic synthesis (Schlenck technique) and analysis (NMR, MS) of precursors, radiolabeling of precursors, PET, MR, SPECT, CT and optical imaging, detailed data analysis of acquired data.
Format	Lectures, practical lab work, data analysis in seminars, literature seminar
Frequency	Summer term
Participants	4-8
Evaluation	Practical evaluation, exam, literature seminar evaluation
Organizers	Andreas Maurer, Nicolas Beziere

External Course: Immunology (BCH-5620)

Goals	Skills: practical skills (experimental planning and execution, data analysis, discussion), presentation, scientific writing Knowledge: theory of immunological methods, insights into aspects of innate and adaptive immunology
Content	Students will be acquainted with the *theoretical background* for the following immunology-related techniques in the introductory lecture block (during first week of the module and separate from the lectures "Einführungsvorlesung Immunologie" and "Advanced Immunology"): - Characteristics of the main innate and adaptive immune cells - Working with blood- and skin-derived immune cells - Isolation and phenotyping of cell types - T-cell based assays and immune monitoring - Immunohistochemistry / Immunofluorescence / Immunoblot / ELISA - Flow cytometry (intracellular and surface stain; phospho-flow cytometry) - Immunological techniques in mice / immunological mouse models In the following 3.5 weeks, 1-2 students will be assigned to the following participating labs offering *insights into their ongoing research* and allowing first-hand *practical experience*. Preferences will be considered if possible. - T-cell assays and immune monitoring (C. Gouttefangeas, Immunology) - Viral vaccine development (R. Amann, Immunology) - Peptide vaccination: from discovery to drugs (J. Walz, Immunology) - gamma-delta T cells (K. Schilbach-Stückle, University Hospital) - Immune cell signaling (S. Beer-Hammer, Toxicology) - Immune responses in the skin towards infection (B. Schittek, Dermatology) - Innate Immunity (A. Weber, Immunology) - Neonatal Immunology (C. Gille, Neonatology) Upon completion of the practical period, students will be requested to: - present their lab project in a short Powerpoint presentation held during a 1-day colloquium in the final week (all students and PIs participate) - generate a report detailing their research topic, data and discussion.

Format	Lectures, practical, colloquium
Frequency	Winter term
Participants	4-10
Evaluation	Students present their lab project in a short Powerpoint presentation held during a 1-day colloquium in the final week (all students and lab supervisors participate). Each short presentation is followed by a short Q&A session to yield a combined final grade.
Organizer	Alexander Weber
Requirements	Attendance of the Immunology lectures at the Department is recommended prior to completion of the course but not formally required. Students with prior knowledge or experience in immunology gained in Tübingen or elsewhere may be given preference should the course be oversubscribed.

External Course: Introduction to metabolic imaging and medical diagnostics (BCH-5630)

Goals	We aim in this module to address several topics in metabolism, physiology, and medical imaging applications. The students will get acquainted with relevant metabolic pathways in cancer cell biology, develop new sensors to access reverted physiology and diagnostic medical applications. The programme will also extend to metabolic imaging in vivo and in vivo/ex vivo analysis. This module will account for the contribution of experts in metabolism, metabolomics, probe development, oncology, cancer stress, neurology, and data analysis.
Content	Topics: Synthesis of organic and inorganic metabolic probes, introduction to cancer metabolism, implement concepts in multimodal metabolic imaging (PET, MRI, Optical, photoacoustics) and applications Students will perform - practical study from probe development to preclinical application in cancer - tissue collection and staining - 1H NMR metabolomics analysis - training on organizing a lab book and biostatistical imaging analysis
Format	Lectures, practical lab work, data analysis workshops
Frequency	Winter term
Participants	4-10
Evaluation	Labbook organization (report) (1/3) Oral presentation followed by a short Q&A session (2/3)
Organizers	Andre F. Martins

External Course: Pathobiochemistry (S01PLAB01)

Goals	Experience in detection of phosphorylated proteins, design and evaluation of experiments for detection of activated signal transduction, understanding and interpretation of pathobiochemical alterations and disease-related biomarkers

	in body fluids, critical presentation and discussion of data, presentation and discussion of scientific publications
Content	Topics: molecular mechanisms of metabolic regulation in health and disease, insulin resistance and diabetic late complications, diagnostic tools for detection of pathobiochemical alterations and disease-related biomarkers in body fluids Methods: cell culture, transfection of cells, immunodetection of phosphorylated proteins, immunoprecipitation, point of care testing
Format	lectures, seminar, practical course
Frequency	Winter term
Participants	4-9
Evaluation	Protocol (not graded) Presentation of a recent scientific paper (graded, 30%) Oral examination (graded, 70%)
Organizers	Cora Weigert, Rainer Lehmann, Andreas Peter
Note	This course consists of three parts: S01PLAB01 (practical), S01SLAB01 (seminar) and S01VLAB01 (lecture). Only the practical part will show on your transcript and in your examination booking, but you need to attend all three parts.

External Course: Mechanisms of Microbial Pathogenicity (Bio-MIB-200, together with Bio-MIB-208)

Goals	Knowledge of molecular and cellular mechanisms of microbial pathogenicity
Content	Theory taught in lectures - How do bacteria survive in humans and cause infections? - How does our defense work and how is it circumvented by bacteria? - Which are the most topical and most urgent infectious diseases? Practical course - *Salmonella* mutagenesis - Functional analysis of the type 3 secretion system - Cell culture infection models of *Salmonella* - Blue native gel electrophoresis
Format	Practical (2-week block S4-slot) Lectures (every Friday 8-10 AM) Seminar (2nd half of summer term, Tuesday 17:00)
Frequency	Summer term
Participants	Up to 3
Evaluation	1/3 each: exam after the lecture, seminar grade, presentation after practical
Organizers	Prof. Samuel Wagner
Note	For the lecture, see also Bio-MIB-208

~~External course: From Gene to Probe: Generation, Profiling and Application of Chemical Probes (PHA-PMC4280 in combination with PHA-PMC4285)~~ not offered currently

Goals	Discussion of current developments of chemical probes to study kinases.
Content	The seminar aims to given an overview on the development of chemical probes and their application in chemical biology and medicinal chemistry. After an overview on the different aspects and sub-disciplines of chemical biology, the generation of chemical probes and their profiling will be discussed. The lecture will be complemented with recent case studies highlighting the respective techniques and giving relevant examples for the use of chemical probes in drug discovery but also in basic research.
Format	Lecture/seminar
Frequency	Each term
Participants	[t.b.a.]
Evaluation	Seminar presentation, Oral Examination
Organizers	Matthias Gehringer
Note	This is a seminar series spanning the whole semester. You need to attend both seminars (listed above), give a presentation and take the exam, if you want this course to be considered for your ToR. Please inform your supervisor that you want to be graded.

External course: Structure-based Drug Design (BIOINF-4371)

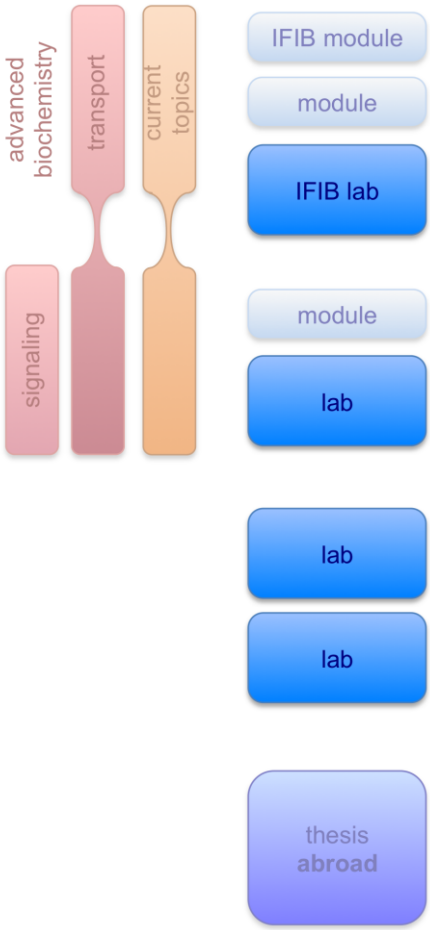
Goals	Students have a working knowledge on the pharmaceutical development process. They are familiar with protein and ligand structures, how to resolve and model them. They can identify relevant physicochemical interactions. Students have detailed knowledge of algorithmic techniques to predict protein-ligand binding and can implement them.
Content	Starting with a broad introduction of the pharmaceutical drug development process, the lecture conveys key concepts of structure-based computer-aided drug design. Required basics on pharmaceutical key concepts are discussed, followed by basic concepts for modelling of 3D structures. In the second part, physicochemical interactions between proteins and ligands are presented, forming the basis to discuss strategies to predict protein-ligand binding with a focus on algorithms for protein-ligand docking. The estimation of binding affinities between proteins and ligands *in silico* is introduced, leading to the discussion, development, and use of scoring functions.
Format	Lecture (2h/week), exercise (2h/week) and project
Frequency	Summer term
Participants	Up to 5
Evaluation	Oral exam or, in case of too many students, written exam. 50% of the achievable points from the assignments and the project, individually, are required for exam admission.
Organizers	Philipp Thiel
Note	No formal requirements. Basic knowledge of protein structure, organic chemistry, and programming skills in Python are recommended. Lectures and exercises span the whole term.

	In summer 2024 lectures were scheduled on Wednesdays 8-10. The date for the exercises will be decided with the participants during the first lecture.

Labs

Labs (or lab rotations) are mini research projects in biochemistry. They will consist of about 2 months of lab work followed by a writing up or a final presentation depending on the group leader. You will arrange your own labs by contacting selected principal investigators. All investigators of the IFIB and external courses organizers automatically belong to this group. For all other labs please contact us first by filling in the lab form.

We are thinking of *labs* as a way for you to test yourself in different research areas of biochemistry. This will help you determine which specialty is most suited to your preferences and skills in a relatively short amount of time. After having explored different corners of biochemistry you will be in a better position to decide where to do a doctorate or in which area of industry to seek employment. For the same reason don't do more than 2 *labs* with the same group.



Labs often cannot be graded reliably because the results depend not only on your skills and work ethics but also on luck in the lab. Also, *labs* done abroad may shorten your effective working time at the bench and thus decrease your data output. This is why we have decided not to ask for these elements of the *Master of Biochemistry* to be graded. We believe this will give you more liberties to test with topics of modern biochemical research interest you.

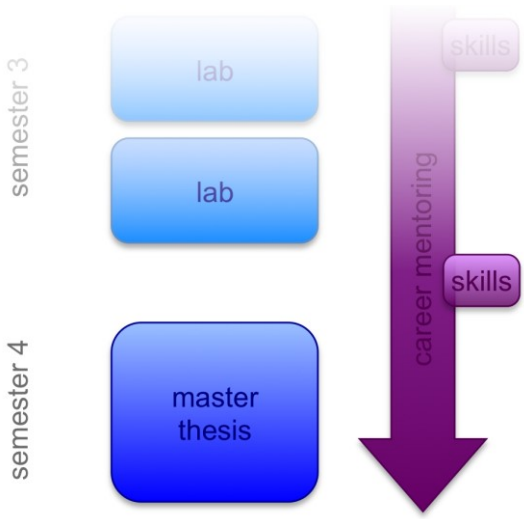
In total, you will select 4 *labs*, one of which has to be at the IFIB. With 4x 15 CPs, or 60 points in total, the *labs* will be the largest part of your master. You can do 1 or more labs in other German laboratories or even abroad. If you want to spend more time on a topic, you can fuse two labs into one for a total of about 4 months.

When looking for a lab, keep in mind that at your stage you require good supervision to learn effectively. This can be harder to find in large, occasionally more impersonal groups. We are collecting your feedback on labs to build a database to help you profit from previous students' experience when looking for labs. This can be especially important for industry labs who are often inaccessible without personal contacts.

Goals	You review published data in preparation for experimental work. You practice the flow from hypothesis, via experimental design including controls, to analysis of the results and interpretation. You accurately document your work and present your data and ideas.
Duration	8 weeks
Evaluation	Audited protocol and oral presentation of the results and/or the theoretical background (all not graded)
Responsible	MSc Biochemistry coordinator
Organizers	IFIB group leaders, course organizers, other labs after confirmation
Credit points	15 CP

Master Thesis

Your master thesis concludes the 2-year degree program with us. After having brushed up on the theoretical underpinnings in the lecture and *Current Topic* series, after having done more organized practical training in several *courses* and then in more self-organized laboratory placements, the master thesis will be your most independent and in-depth piece of research to date.



This is reflected in its setup. The longer time allotted gives you more time to dig deeper into the topic of your choice. More than in the *labs* before, we expect you to actively develop your research plan before conducting experiments. The write up will also be more extensive and evaluated more thoroughly.

After doing several *labs*, you will have gained a good overview of several biochemical research areas. Carefully choose which thesis topic is most suited as it will influence future choices regarding a doctorate or your job search. The topic of the master thesis has to be clearly separate from any previous projects in the same lab, if any.

As with the *labs*, the master thesis can also be done abroad if you wish. As it needs to be formally graded and influences your final master grade, please consult us during your decision process. You will also need a 2nd supervisor in the IFIB.

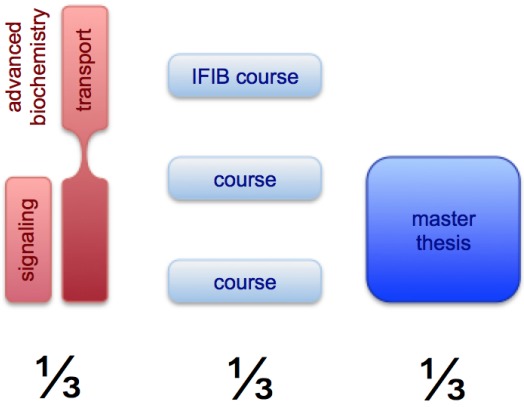
We hope that the master thesis will bring you a step closer to becoming an independent and fully fledged biochemical researcher.

Goals	You survey published data to develop a novel hypothesis or find an unanswered questions You devise an experimental plan incl. suitable methods, controls, and timing You write up your work accurately and present your new findings.
Format	Practical work
Duration	6 months
when?	4th semester
prerequisite	3 courses, 4 lab projects
Evaluation	Oral presentation of results (not graded) Written thesis (⇒ graded by supervisor and if necessary a 2nd reviewer)
Responsible	Head of the examination committee
organizers	IFIB group leaders, course organizers, other labs after confirmation
Credit points	30 CP

Final Grade

As you progress from undergraduate studies via the master with us to a doctorate or employment outside academia, grades become less important and experimental skills, experience, contacts, and publications gain in weight. Nevertheless, the final grade of the *Masters in Biochemistry* will be of some influence.

The final grade is composed in equal part of the grades of the *Advanced Biochemistry* lecture series, your 3 best *courses*, and the master thesis. If you completed 4 courses, the best grades will be used automatically. It will thus be based in equal parts on the oral examination after the lectures, the mean grade of your *courses*, and the overall grade of your master thesis. On average you get 1 to 2 grades per term.



Links

We will use the platforms **ILIAS** and **Alma** as a principle way of organizing the courses and we hope that you will use your editing rights there to exchange information between each other and with us. There, you will find all elements of the current semester represented as ILIAS objects. In addition, there is a collection of frequently asked questions, useful links, and areas with content jointly generated by students and faculty.

Remember to regularly check our **calendar** for module changes and additional events: http://tinyurl.com/mbioch-cal.

Preparation

If your bachelor was in a related discipline or if you just want to brush up a little to be able to start at full speed, we recommend the following **books**: Alberts, *Molecular Biology of the Cell*, 2014; Lodish, *Molecular Cell Biology*, 2016; Berg,.. Stryer, *Biochemistry*, 2019; Nelson and Cox (Lehninger), *Principles of Biochemistry*, 2017; Voet and Voet, *Fundamentals of Biochemistry*, 2016.

Also, we would recommend to read current research **articles**. The following journals are usually a good choice: *eLife*, *Nature*, *Science*, or *Cell*.

To tune into the spoken scientific language, browse the following site for scientific **talks**: TED (not all biochemistry, http://tinyurl.com/n3yndqv), Nobel talks (nobelprize.org/mediaplayer/), HS talks (only the first minutes free, http://tinyurl.com/m2uh8ds).

And/or consider taking an **online course** on *edX*.org or *Coursera*.org.