

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.



Jakob Suckale, 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
3 Courses	6+6+6
4 Labs	15+15+15+15
Master Thesis	30
	<hr/>
	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 quantified feedback on your presentation and writing skills during the Current Topics seminars. Based on this evaluation, you can decide to take optional skill courses to improve the above. 5 lab projects in total and a dedicated planning and analysis workshop will increase your capacity to organize.

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

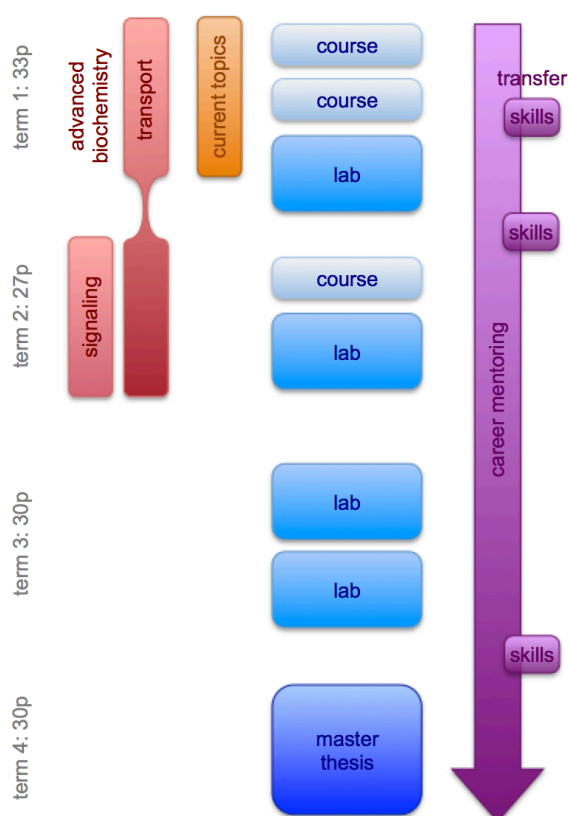
The 1st year kicks off with a joint lectures series by all the research group leaders of the institute. Departing from the basics you have acquired in your previous degree, this series takes you into the advanced topics of biochemistry and to the research frontier. In parallel, you will choose your first *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 and we hope that you will actively join our alumni network called *Mobbel*.



REQUIREMENTS

Please refer to our webpage (<http://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

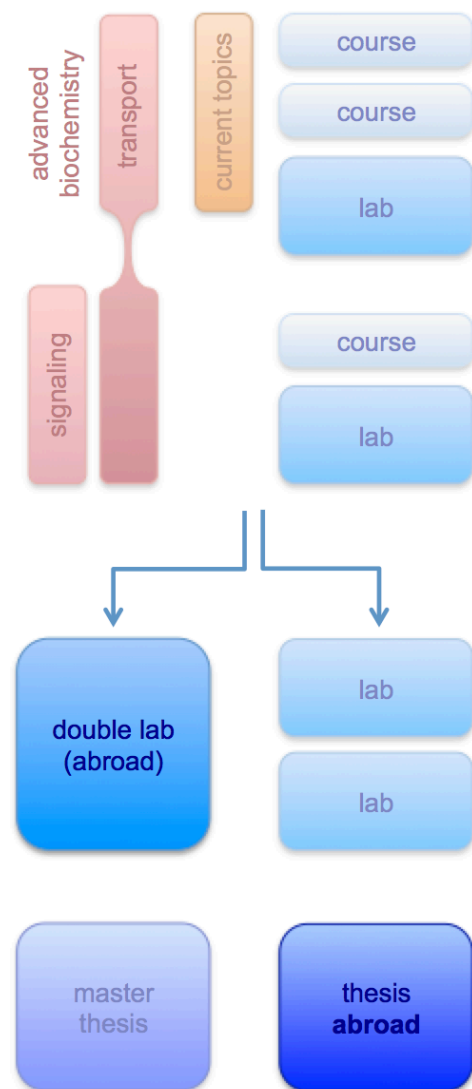
Here are a few ideas on how to adapt the template presented on the previous page to your personal preferences. Many variations are possible. Please discuss them with us.

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. Also, 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. Keep in mind though that the 1st part of the transport lectures is conceptually positioned before the 2nd. The same goes for *Current Topics*. We recommend starting them 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 (fall + spring) while the signaling lectures are all in the spring semester. It complements the practical training that you will receive via courses and labs.

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, hormones
Format	<ul style="list-style-type: none">• Cellular transport processes (2 hours/week in fall and 2 in spring term)• Signal transduction (2 hours/week in spring term)
Duration	2 semesters in total (3x 1 semester series)
Recommended semester	<ul style="list-style-type: none">• 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

The approximate overview of topics is indicated in the table. 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 spring, we recommend to take the fall 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.



Suckale	types of cellular movement, energetics, mechanics, evolution
Rapaport	lipids transmembrane transport
Dodt	membrane dynamics, vesicle transport
Stehle	virus entry glycosylation
Jansen	cytoskeleton / motors RNA transport
Schwarzer	transport visualization nuclear import drug delivery

Signaling - Advanced Biochemistry

In spring, 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 plus researchers from the next-door ZMBP, specializing in plant biochemistry, one of the strengths of Tübingen.

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.



Suckale	principles, types, and range molecular signaling toolbox
Schulze-Osthoff	signaling in apoptosis and cancer
Nürnberger and Felix	immunity signals in plants
Feil	cardiovascular signaling

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 <http://www.ifib.uni-tuebingen.de/master/examinations.html>.

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 and dynamic format rather than a typical frontal lecture.

Goals	You critically summarize and present a recent technology / discovery. You critically review a current topic in a written essay. 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, quizzes, presentations, and a writing session
Duration	1 term
Recommended semester	1 st or 2 nd term
Frequency	10-12 invited speakers (typically Mondays) per term Current topic seminars every fall term
Evaluation	Participation and attendance during 1 term (not graded) Your presentation and written review will receive a score for your orientation.
Responsible	Jakob Suckale
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

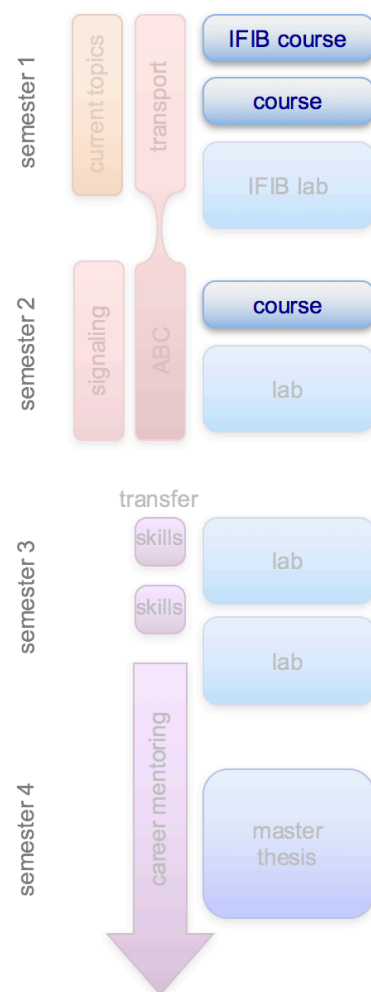
Courses are intended as both a transition from group practicals to independent research and as a way to connect with your class mates and build your network. In contrast, during the *Labs* you will rarely coincide with other master students. *Courses* last about a month and consist of about 90 hours 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)
- Disease mechanisms (Suckale)
- Genetic engineering (Gust, Fuß)
- Membrane organization & dynamics (Garcia-Sáez)
- Molecular oncology (Schulze-Osthoff)
- Innate immunity animals/plants (Nürnberger & Felix)
- Post-transcriptional control / RNA (Jansen & Stafforst)
- Science of cooking (Garcia, Suckale)
- Structural biology (Stehle)

Courses from contributing investigators

- Imaging from probe dev't to in vivo application **NEW**
- Cell bio. w/ fluorescent fusion proteins (Rothbauer)
- Drug discovery technologies (Böckler, Exner)
- Immunology (Weber & colleagues)
- Microbial pathogens (Peschel, Götz & Wolz)
- Microscopy techniques (Liebig)
- Osteogenesis and wound closure (Ehnert, Nüssler)
- Pathobiochemistry (Weigert)



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.

Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat
29	30	Oct 1	2	3	4	5	27	28	29	30	31	Nov 1	2
							module Jansen						
							module Rothbauer						
								8:15am Adv. Bi			8:15am Curren		
6	7	8	9	10	11	12	3	4	5	6	7	8	9
			welcome events IFIB				module Jansen						
							module Rothbauer						
								8:15am Adv. Bi			8:15am Curren		
13	14	15	16	17	18	19	10	11	12	13	14	15	16
	module Jansen							module Schwarzer					
	module Rothbauer							module Stehle					
	start WS13	8:15am Adv. Bi		8:15am Curren				8:15am Adv. Bi			8:15am Curren		
20	21	22	23	24	25	26	17	18	19	20	21	22	23
	module Jansen						module Schwarzer						
	module Rothbauer						module Stehle						
		8:15am Adv. Bi		8:15am Curren				8:15am Adv. Bi			8:15am Curren		
27	28	29	30	31	Nov 1	2	24	25	26	27	28	29	30
	module Jansen							module Schwarzer					
	module Rothbauer							module Stehle					
		8:15am Adv. Bi		8:15am Curren				8:15am Adv. Bi			8:15am Curren		

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 fall and spring 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

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	<u>Topics</u> : mitochondrial biogenesis and morphology; peroxisome dynamics and function <u>Methods</u> : subcellular fractionation, fluorescence microscopy, native gel electrophoresis, transfection of cell cultures, RNAi, quantitative RT-PCR, yeast genetics
Format	Lecture, seminar, practical course
Frequency	Each spring 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 – Innate Immunity Animals / Plants

Goals	Understand innate immunity and signaling in plants and animals; employ current plant biochemistry methods; plan and work independently in the lab as well as together as a team; present your research results
Content	Comparative innate immunity in animals and plants (lecture series); modern molecular methods of cell biochemistry with the model system of plant/pathogen interaction
Format	Lecture series (http://bit.ly/2fTel39 *) Practical course (http://bit.ly/2fU7SoQ *, groups of 2)
Frequency	Lectures each fall term (1 weekly lecture) Practical course (2 weeks at the end of the fall term; Jan/Feb) Optional seminar in spring to write a research project
Participants	Up to 2
Evaluation	Protocol (5-10 pages incl. introduction, methods, results & discussion) (100%)
Organizers	Thorsten Nürnberger, Georg Felix, Birgit Kemmerling, Andrea Gust, Markus Albert; *Links are to '17/18. Change to the current semester if applicable.

IFIB Course - Cell Signaling

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	<u>Topics</u> : signal transduction in mammalian cells, with a focus on the cardiovascular system; visualization of signaling molecules in real time in

	<p>living cells; cell death and survival; transgenic mice as models for human diseases; stem cell biology; regenerative medicine</p> <p><u>Methods:</u> 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</p>
Format	Lecture/seminar, final seminar Practical course
Frequency	Each spring term
Participants	4-12
Evaluation	Protocol (graded, 25%) Performance at work (graded, 25%) Oral examination (graded, 50%)
Organizers	Robert Feil, Susanne Feil, Markus Wolters

IFIB Course - Chemical Biology

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	<p><u>Topics:</u> posttranslational modifications of proteins, chemical labeling of proteins, protein chemistry</p> <p><u>Methods:</u> solid-phase peptide synthesis, organic chemistry, protein semi-synthesis, methods for purification and analyses of semisynthetic proteins</p>
Format	Lecture, seminar, practical course
Frequency	Every term
Participants	2-6
Evaluation	Protocol (10-15 pages including introduction, results and discussion) 50% Oral examination (20 minutes) 50%
organizer	Dirk Schwarzer, Thorsten Stafforst

IFIB Course - Disease Mechanisms

Goals	<p>Gain a basic biochemical understanding of human disease processes</p> <p>Summarize a disease mechanism with text and figures</p> <p>Review a scientific text and suggest improvements</p> <p>Discuss and debate a scientific topic</p>
Content	<p>This course will explore the bewildering spectrum of molecular mechanisms that lead to disease in humans. We will look at problems caused by other species and by our own body, syndromes of dearth as well as plenty, damage done by the chemical as well as the physical, and diseases of development and degeneration.</p> <p>While we cover these mechanisms you will gain a basic biochemical understanding of the human body, its workings, and derailments. You will learn why certain common diseases arise and you will discover that in many cases it is far from clear why they do. You will see that diseases were in the</p>

past named and grouped according to their symptoms, some times placing diseases caused by very similar mechanisms confusingly far apart. You will see that knowing the mechanism of a disease is the crucial piece of information required before a treatment can be logically devised.

As part of the course you will prepare a review with text, figures, and citations on a disease of your choosing. You will check somebody else's review and you will take part in a debate.

Format	Seminars/discussion + practical + lab seminar	
Frequency	Each spring term	
Participants	3-6	
Evaluation	Written review & peer review	(1/3 of final grade)
	Participation	(1/3)
	Oral examination	(1/3)
Organizers	Jakob Suckale	

IFIB Course - Membrane Organization & Dynamics

Goals	Understanding the principles of organization and dynamics of biological membranes; role of biochemical and biophysical research, with a focus on quantitative approaches, to improve our understanding of biological membranes; experience in preparation, handling and analysis of membrane model systems; design and performance of well-controlled experiments; documentation and interpretation of data; critical presentation and discussion of data	
Content	<p><u>Topics:</u> principles of lipid membrane assembly and structure; heterogeneity in membrane composition and its relation to function; membrane fluidity; membrane shape and its determinants; dynamic processes in membranes, with a focus on shape changes, permeabilization, fusion and fission</p> <p><u>Methods:</u> preparation model membrane systems for microscopy experiments; imaging of dynamic processes in membranes; analysis of membrane fluidity and lateral organization; characterization of lipid phase diagrams; assays of membrane permeabilization at the single vesicle level, including kinetics, filling degree and pore size and stability; image processing and quantitative data analysis</p>	
Format	Seminar, final seminar, practical course	
Frequency	Every term	
Participants	4-8	
Evaluation	Protocol (graded, 25%)	
	Performance at work (graded, 10%)	
	Seminar presentation (graded, 25%)	
	Oral examination (graded, 40%)	
Organizers	Ana J. García-Sáez	

IFIB Course - Modern Genetic Engineering

Goals	Overview of the most important methods of modern genetic engineering and their application in plants	
Content	<u>Methods applied:</u> PCR mutagenesis, Gateway cloning, DNA sequencing, transient protein expression, transformation and PCR analysis, synthetic gene	

	design <u>Methods discussed:</u> generation of genetically modified organisms, virus-induced gene silencing, amiRNA technology, TALEN, lambda-red
Format	Lectures, seminar, practical course
Frequency	Beginning of spring 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

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	<u>Topics:</u> 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. <u>Methods:</u> 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, lecture
Frequency	Labs each spring term, lecture series in fall
Participants	4-12
Evaluation	Lab protocol (1/3 of final grade) Performance at work (1/3 of final grade) Lecture (Advanced Oncology) + written exam (1/3 of final grade)
Organizers	Klaus Schulze-Osthoff, Frank Essmann
Note	requires prior participation in the lecture and passing of the written exam

IFIB Course - Posttranscriptional Control of Gene Expression

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	<u>Topics:</u> mRNA stability; translation and its control; RNA-binding proteins <u>Methods:</u> Northern blot; qRT-PCR; quantitative Western blot; RNP purification; ribosome binding assays
Format	Lecture, seminar, practical course

Frequency	Fall term
Participants	4-16 (fall)
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

Goals	Understand the general flow of a structural analysis, practice of different methods of crystallography (SIR, MAD, MR), identification of a protein by 3D-NMR, set-up and analysis of NMR structure calculation, evaluation of published data (significance, quality)
Content	<u>Topics:</u> Practical aspects of structure determination using modern X-ray crystallographic and NMR spectroscopic methods. Students will be trained to solve structures and interpret their validity. <u>Methods:</u> X-ray crystallography, NMR spectroscopy
Format	Lecture/seminar, practical course
Frequency	Every term
Participants	4-8
Evaluation	Oral examination (⇒ grade)
Organizers	Thilo Stehle, Remco Sprangers, Silke Wiesner
Note	Course requires the participation in a preparatory lecture series in fall

IFIB Course – Science of Cooking

Goals	Understand the components of food and their positive and negative role. Why is food prepared and how? Acquire a basic knowledge of food related diseases. Quantitatively analyze the preparation of food and drink.
Content	History of science and cooking, food components, basic transformation processes during cooking: phase transitions, energy, temperature and heat transfer; elasticity and texture; diffusion and spherification; viscosity and polymers; emulsions and foams; baking and fermentation; applications in haute cuisine and food industry.
Format	Lectures, exercises and practical course
Frequency	Every spring term
Participants	0-2 (together with up to 6 BSc students)
Evaluation	Oral exam 60% Protocol 20% Project 15% Active participation 5%
Organizers	Ana J. García-Sáez, Jakob Suckale

External Course - Modulating osteogenesis and wound closure *in vitro*

Goals	<p>Experience in handling of cell cultures (isolation, expansion and differentiation of primary human osteoblasts)</p> <p>Design and evaluation of experiments for determining the effect of biological substances/epigenetic drugs on osteoblast growth and function</p> <p>Team work (groups of 2)</p> <p>Presentation and discussion of the experimental results in English</p>
Content	<p><u>Topic:</u> Evaluating the effect of various biological substances/ epigenetic drugs on osteoblast growth and function (osteogenesis)</p> <p><u>Methods:</u> 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</p>
Format	Lecture/seminar, practical course
Frequency	Each term
Participants	2-4
Evaluation	<p>Written summary (2-5 pages) incl. materials, methods & results (30%)</p> <p>Performance at work (30% of final grade)</p> <p>Talk/poster presentation (40%)</p>
Organizers	Dr. Sabrina Ehnert, Prof. Andreas Nüssler

External Course - Cell Biochemistry with Fluorescent Fusion Proteins

Goals	<p>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.</p>
Content	<p>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.</p>
Format	Practical course, seminar
Frequency	Each fall term
Participants	2-4
Evaluation	<p>Oral presentation at the start (1/3 of grade)</p> <p>Audited protocol (1/3 of grade)</p> <p>Oral examination (1/3 of grade)</p>
Organizers	Prof. Dr. Rothbauer

External Course - Drug Discovery Technologies

Goals	Gaining basic knowledge and hands-on experience in the application of (bio-)chemical, biophysical, and computational techniques for drug discovery.
Content	<p>Students typically select one of 3 fields of research: (a) chemical biology / medicinal chemistry, (b) molecular biology & biophysics, (c) computational biology & <i>in silico</i> drug discovery.</p> <p>Tasks in these fields are: (a) synthesis and chemical characterization of tool compounds for studying biological processes; assay design & development utilizing such new compounds; studying structure-activity relationships in lead development and optimization for elucidating key protein-ligand interactions and their cooperativity; (b) construction and expression of vectors for protein production; application of protein purification strategies; characterization of protein-ligand interactions with biophysical techniques including NMR, ITC, DSF, fluorescence polarization, etc.; implementation of compound screening strategies and use of automation for improving throughput; (c) modeling chemistry and biology at different levels of theory (QM, sQM, MM); studying the dynamic behavior of proteins and protein-ligand interactions; computational structure-based drug design; application of virtual screening techniques including pharmacophores and (high-throughput) docking.</p>
Format	Seminar, practical course
Frequency	Once per year (seminar: during spring term; practical course: 3 weeks in August – October by individual arrangement must be scheduled at the start of each spring term)
Participants	Up to 6
Evaluation	Audited protocol (~10 pages summary of research results + lab book) 50% Oral presentation (~10 minutes) 50%
Organizers	Frank Böckler, Thomas Exner

External Course – Imaging from probe development to in vivo application

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	<p>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.</p> <p>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.</p>
Format	Lectures, practical lab work, data analysis in seminars, literature seminar
Frequency	Yearly
Participants	4-8
Evaluation	Practical evaluation, exam, literature seminar evaluation
Organizers	Florian Maier, Andreas Maurer

External Course - Immunology

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 <i>theoretical background</i> for the following immunology-related techniques in the introductory lecture block: <ul style="list-style-type: none">- 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 <i>insights into their ongoing research</i> and allowing first-hand <i>practical experience</i> . Preferences will be considered if possible. <ul style="list-style-type: none">- T-cell assays and immune monitoring (C. Gouttefangeas, Immunology)- Peptide vaccination: from discovery to drugs (S. Stevanovic, Immunology)- Immune responses in the skin towards infection (B. Schittek, Dermatology)- Immune responses in the context of cancer (H. Braumüller, Dermatology)- Innate Immunity (A. Weber, Immunology)- Dendritic cell immunity (S. Autenrieth, Internal Medicine) Upon completion of the practical period, students will be requested to: <ul style="list-style-type: none">- 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	Each fall 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) - 50% of the final grade Participants also generate a protocol/report detailing their research topic, data and discussion - 50% of the 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 - Pathobiochemistry

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	<u>Topics</u> : 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 <u>Methods</u> : cell culture, transfection of cells, immunodetection of phosphorylated proteins, immunoprecipitation, point of care testing

Format	lectures, seminar, practical course
Frequency	Each fall term
Participants	4-8
Evaluation	Protocol (not graded) Presentation of a recent scientific paper (graded, 30%) Oral examination (graded, 70%)
Organizers	Cora Weigert, Rainer Lehmann, Andreas Peter, Erwin Schleicher, Harald Staiger, Susanne Ullrich

External Course - Mechanisms of Microbial Pathogenicity

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 - <i>Salmonella</i> mutagenesis - Functional analysis of the type 3 secretion system - Cell culture infection models of <i>Salmonella</i> - Blue native gel electrophoresis
Format	Practical (2-week block end of spring term) Lectures (fall term every Friday 8-10 AM) Seminar (Jan/Feb Monday 16:30)
Frequency	Once per year (fall + spring)
Participants	Up to 4
Evaluation	1/3 each: exam after the lecture, seminar grade, presentation after practical
Organizers	Prof. Christiane Wolz, Prof. Samuel Wagner, Dr. Weidenmaier, Dr. Jürgens, Dr. E. Bohn, Prof. Andreas Peschel, Prof. Fritz Götz
Note	See also <i>W-Schiene: Mechanismen der Pathogenität von Mikroorganismen (4050)</i> , e.g. http://bit.ly/1bLV0ru .

External Course - Microscopic Imaging Techniques

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 and electron 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	Each fall term
Participants	4-8
Evaluation	Written examination

Organizers

Christian Liebig, Matthias Flötenmeyer, Gaspar Jekeley, Andrew Renault,
Frank Schleifenbaum, York Stierhof

LABS

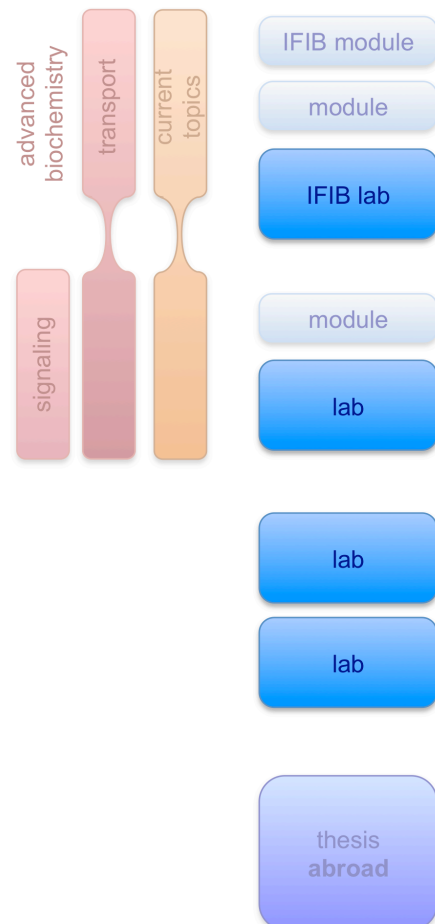
Labs are mini research projects in biochemistry. They will consist of about 2 months of lab work followed by a writing up or a final presentation depending on the group leader. You will arrange your own labs by contacting selected principal investigators. All investigators of the IFIB and external courses 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 in 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 to 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	<p>You review published data in preparation for experimental work.</p> <p>You practice the flow from hypothesis, via experimental design including controls, to analysis of the results and interpretation.</p> <p>You accurately document your work and present your data and ideas.</p>
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

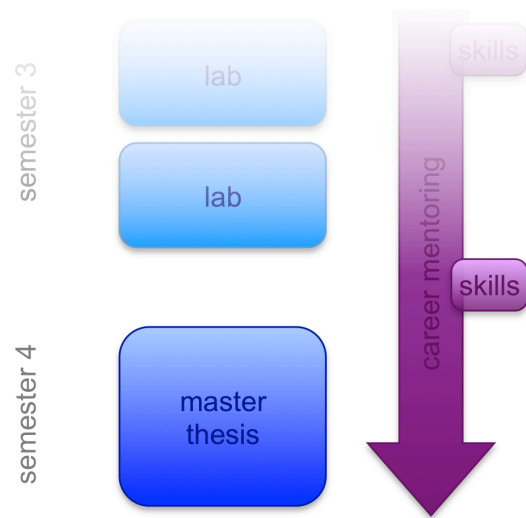
Your master thesis concludes the 2-year degree program with us. After having brushed up on the theoretical underpinnings in the lecture and *Current Topic* series, after having done more organized practicals in several *courses* and then in more self-organized laboratory placements, the master thesis 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.

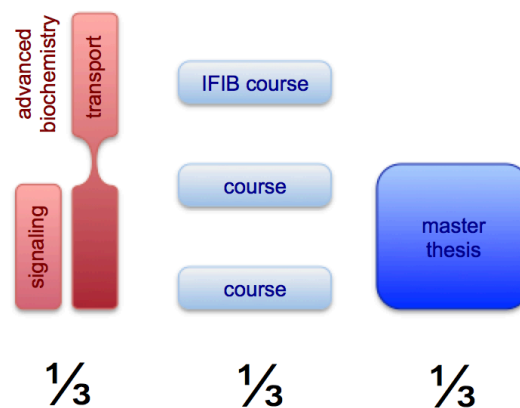


Goals	You survey published data to develop a novel hypothesis or find an unanswered questions You devise an experimental plan incl. suitable methods, controls, and timing You write up your work accurately and present your new findings.
Format	Practical work
Duration	6 months
when?	4 th semester
prerequisite	3 courses, 4 lab projects
Evaluation	Oral presentation of results (not graded) Written thesis (⇒ graded by supervisor and if necessary a 2 nd 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 **ILIAS** platform (<https://ovidius.uni-tuebingen.de/ilias3/>) 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>.

Wondering where things are? Check the **map**: <http://tinyurl.com/mbioch-map>.

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, <http://amzn.to/1K22W7r>, Berg,.. Stryer, *Biochemistry*, 2015, <http://amzn.to/1ExNQAt>.

Also, we would recommend to read current research **articles**. The following journals are usually a good choice: *eLife*, *PLoS Biology*, *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.