Modulhandbuch

Master of Science

Biochemistry

Modul: **Methods in life sciences and statistics**				UNIVERSITÄT BONN
Module Number LIMES-001	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Christoph Thiele, Prof. Dr. Matthias Schmid			
Providing institution	LIMES-Institute Institute of Medical Biometry, Medical Informatics, and Epidemiology			

	Study course	Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc) Medical Immunosciences and Infections (MSc)	P	1.

Learning objective	Students should learn theoretical background of common techniques and methodological approaches from the area of life sciences. Additionally, students will gain an understanding of hypothesis testing and correct interpretation of different types of test statistics. They will improve their skills in statistical calculations and adequate planning of experiments.
Skills	Profound knowledge on methodology in life sciences Being able to perform statistical analysis of obtained results
Content	Dealing with DNA, RNA, proteins and lipids, electrophoresis, western blotting, RT-PCR, protein purification, cloning technologies, analysis of lipids, immunoprecipitation, histology, ELISA, Flow cytometry, FRET, microscopy Statistics: Basic test theory, Chi²-tests for contingency tables, t-tests, Non-parametric tests, Power calculations, Calculation rules for probabilities, Correlation, Regression, Software implementations, Graphics and visualization
Requirements	none

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Methods in Life sciences and statistics	85	2	90

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam	Graded
Requirements for admission to exam		graded/ungraded
Miscellaneous		

Modul: **Methods course I**				
Module Number LIMES-002	Workload 450	CP 15	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Günter Mayer			
Providing institution	LIMES-Institute			

	Study course	Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)	P	1.

Learning objective	Students should learn to plan and conduct basic biochemical or molecular biological experiments either on their own or within groups based on a simple task.
Skills	By the end of the course, students should know and be able to apply the principles of planning and performing an experiment, searching for references and literature, reading, understanding and discussing the content of primary research papers. They should understand the methods in biochemical research.
Content	Cloning of DNA, isolation of lipids, proteins, metabolites, DNA or RNA from tissues, purification of recombinant proteins, enzyme activity assays, plasmid transfection, theory and practice on buffer generation
Requirements	none

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Practical course	Methods in Life sciences	65	10	450

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam Protocol	Graded (50%) Graded (50%)
Requirements for admission to exam	Records of conducted experiments	graded/ungraded ungraded
Miscellaneous		

Modul: **Introduction in experimental animal techniques and bioethics**				UNIVERSITÄT BONN
Module Number LIMES-003	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Irmgard Förster			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)		P	2.
Learning objective	Students should obtain a comprehensive overview of available animal models and be acquainted with the relevant legal and bioethical guidelines of animal experimentation, as well as general rules for good scientific practice.			
Skills	Understanding the advantages and disadvantages of different animal models and their possible application in biomedical research; knowledge of the methodology of animal experimentation and gene targeting techniques; ability to observe animal protection laws and to apply 3R strategies			
Content	Common laboratory animal models (drosophila; zebra fish, mouse); breeding requirements and animal welfare; importance of genetic background and environmental influences (nutrition; microbiota); in vivo studies of development, metabolism, immunology, neurobiology and behavior; anesthesia and analgesia; gene targeting techniques (homologous recombination in embryonic stem cells; TALEN and CRISPR-Cas technology); German/European legislation for the protection of animals; bioethics and the 3Rs; experimental design and good scientific practice			
Requirements	none			
Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Experimental animals and statistics	65	2	90
Examinations	Prüfungsform(en)			graded/ungraded	
	Written exam			Graded	
Requirements for admission to exam	none			graded/ungraded	
Miscellaneous					

Modul: **Methods course II**				UNIVERSITÄT BONN
Module Number LIMES-004	Workload 450	CP 15	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Günter Mayer			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)		P	1.
Learning objective	Students should learn to plan and conduct basic biochemical or molecular biological experiments either on their own or within groups based on a simple task.			
Skills	By the end of the course, students should know and be able to apply the principles of planning and performing an experiment, searching for references and literature, reading, understanding and discussing the content of primary research papers. They should understand the methods in biochemical research.			
Content	Advanced techniques in life sciences including different types of microscopy, basic principles of fluorescence, flow cytometry and ELISA			
Requirements	none			

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Practical course	Methods in Life sciences	65	4	180

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam Protocol	Graded (50%) Graded (50%)
Requirements for admission to exam	Records of conducted experiments	graded/ungraded ungraded
Miscellaneous		

Modul: **Cellular Biochemistry**				UNIVERSITÄT BONN
Module Number Biochem-001	Workload 180	CP 6	Duration 2 Semester	cycle annual
Representative	Prof. Dr. Christoph Thiele			
Providing institution	LIMES-Institute			

	Study course	Category	Semester
	Biochemistry (MSc)	P	1+2.

Learning objective	Students should learn the biochemical basis of complex cellular function with a focus on major metabolic functions and their pathological aberrations.
Skills	Detailed knowledge of biochemical pathways and their integration into cellular and tissue homeostasis Knowledge of organelle structure and function, and of compartmentalization of biochemical pathways Knowledge of regulatory elements to maintain metabolic homeostasis Be able to read, understand and present advanced issues in biochemistry and metabolism
Content	Organelles and their metabolic pathways (membranes, nucleus, ER, lipid droplets, peroxisomes, mitochondria, endosomes, cytoplasm) Regulation and Signalling (Basic receptors and signal transduction mechanisms, glucose and cholesterol homeostasis) Biochemical basis of disease (ER stress, metabolic overload, protein aggregation, ABC transporter dysfunction)
Requirements	This lecture does not repeat basic knowledge that is a prerequisite to its understanding: Basic protein structure and folding, DNA structure and replication, Michaelis-Menten-type kinetics, basic metabolic pathways (Glycolysis, gluconeogenesis, TCA cycle, glyoxalate cycle, pentose phosphate pathway, glycogen metabolism, respiratory chain and ATP synthase, amino acid synthesis and degradation, fatty acid synthesis and beta-oxidation)

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Cellular Biochemistry	40	2	90
	Tutorial			1	45
	Seminar			1	45

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam	Graded
Requirements for admission to exam	Participation to seminars	graded/ungraded
		ungraded
Miscellaneous		

Modul: **Biophysics**				UNIVERSITÄT BONN
Module Number Biochem-002	Workload 180	CP 6	Duration 2 Semester	cycle annual
Representative	Prof. Dr. Thorsten Lang			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc)		P	1+2.
Learning objective	Students should obtain advanced knowledge about biophysical methods for studying biochemical reactions and macromolecular complexes.			
Skills	Being capable of understanding modern biophysical techniques used in biochemistry.			
Content	Fluorescence correlation spectroscopy, dynamic light scattering, thermophoresis, isothermal titration calorimetry, FRET, EPR, electron microscopy techniques, modern microscopy for studying macromolecular complexes (PALM/STORM, STED microscopy).			
Requirements	none			

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Biophysics	40	2	90
	Tutorial			1	45
	Seminar			1	45

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam	Graded
Requirements for admission to exam	Participation to seminars	graded/ungraded ungraded
Miscellaneous		

Modul: **Biochemistry and Organic Chemistry**				UNIVERSITÄT BONN
Module Number Biochem-003	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Christoph Thiele and Prof. Dr. Michael Famulok			
Providing institution	LIMES-Institute			

	Study course	Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)	WP	1.

Learning objective	Students should learn the basic structures and pathways in biochemistry and the key organic reactions and reaction mechanisms of relevance for understanding how some biochemical processes work on a chemical basis, in particular enzymatic reactions.
Skills	Basic knowledge of biochemical pathways Knowledge protein structure and function Knowledge of basic regulatory elements to regulate enzyme activity Understanding the key principles of Organic Chemistry, particularly activation of chemical bonds and reaction mechanisms. Being able to read and understand and present fundamental issues in biochemistry and organic chemistry
Content	Basic protein structure and folding, DNA structure and replication, Michaelis-Menten-type kinetics, basic metabolic pathways (Glycolysis, gluconeogenesis, TCA cycle, glyoxalate cycle, pentose phosphate pathway, glycogen metabolism, respiratory chain and ATP synthase, amino acid synthesis and degradation, fatty acid synthesis and beta-oxidation) Key principles of organic reaction mechanisms, key organic reactions of relevance for biological systems with an emphasis on enzymatic mechanisms, basic principles of activation / deactivation of chemical bond breakage and formation, basic principles of some synthetic procedures with emphasis on biological molecules such as DNA, RNA, and peptides.
Requirements	none

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Biochemistry and organic chemistry	65	2	90

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam	ungraded

Requirements for admission to exam	None	graded/ungraded
Miscellaneous		

Modul: **Cellbiology and Immunology**				UNIVERSITÄT BONN
Module Number Immuno-002	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Sven Burgdorf and PD Dr. Marc Beyer			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)		WP	1.
Learning objective	Students should apply fundamental knowledge on basic cell-biological and immunological topics on a cellular and molecular level			
Skills	Understanding the key principles in cell biology and immunology			
Content	Molecular biology of the cell, cellular compartments, biological membranes, nucleic acids, protein synthesis and degradation, post-translational trafficking of proteins, post-translational modifications of proteins, signaling mechanisms and second messengers, cytoskeleton, endocytosis, energy metabolism in mitchondria, extracellular matrix, cells of the immune system, basic principles of the immune system.			
Requirements	none			
Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Cell Biology and Immunology	65	2	90
Examinations	Prüfungsform(en)			graded/ungraded	
	Written exam			ungraded	
Requirements for admission to exam	None			graded/ungraded	
Miscellaneous					

Modul: **Genetics and Molecular Biology**				UNIVERSITÄT BONN
Module Number Immuno-003	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Michael Pankratz and PD Dr. Reinhard Bauer			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)		WP	1.
Learning objective	Students learn general concepts of the interactions between various systems of cell and gene regulation and how they can be studied.			
Skills	Understanding the principles of molecular biology and genetics, and combining this knowledge with biology, biochemistry, advanced genetics (genetic engineering) and genomics/bioinformatics			
Content	Organization of eukaryotic cells and their dynamic functions. Molecular structure and function of DNA and RNA and the mechanisms of replication and transcription. Design and cloning of expression vectors and monitoring gene expression experimentally in whole animals and through quantitative PCR. Description of major mechanisms of signal transduction and how to study such mechanisms by using transgenic animals and forward and reverse genetic methods.			
Requirements	none			
Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Genetics and Molecular Biology	65	2	90
Examinations	Prüfungsform(en)			graded/ungraded	
	Written exam			ungraded	
Requirements for admission to exam	None			graded/ungraded	
Miscellaneous					

Modul: **Inorganic Chemistry and Physical Chemistry**				UNIVERSITÄT BONN
Module Number Biochem-004	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Thorsten Lang			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)		WP	1.
Learning objective	Students should obtain basic knowledge of inorganic chemistry and physical chemistry			
Skills	Being capable of understanding fundamental mechanisms on the level of single atoms or small molecules.			
Content	Inorganic chemistry: salts, ions, hydration, coordination chemistry, acids and bases, inorganic reactions, solubility product Physical chemistry: thermodynamics (kinetic gas theory, enthalpy, entropy, free enthalpy) and kinetics (reaction order, transition states, catalysis)			
Requirements	none			

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Inorganic and Physical Chemistry	65	2	90

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam	ungraded
Requirements for admission to exam	None	graded/ungraded
Miscellaneous		

Modul: **Insights in the workflow of life science companies 1**				UNIVERSITÄT BONN
Module Number LIMES-005	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Joachim Schultze			
Providing institution	LIMES-Institute			

	Study course	Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)	WP	2.

Learning objective	Students should get insights into basic work routines, operational procedures, organizational structures and employment opportunities for scientists with a master's or PhD degree in molecular and systems immunology or related life science degrees in general and particular in respect to organizations focusing on immune system-related products or services.
Skills	Being able to understand, classify and judge the employment opportunities for scientists with a master's or PhD degree in molecular and systems immunology or related life science degrees in industry or other areas within the private sector (e.g. funding agencies, foundations, non-profit organizations, etc.) Get firsthand knowledge about employment opportunities and start networking with colleagues within the private sector
Content	Students will get the opportunity to visit two selected organizations within the private sector to get insights into how these organizations operate, how they are organized, and what the working conditions are. An emphasis will be research and development within these organizations. Students will also learn to organize such visits autonomously. Concerning the format of the visits students will be granted sufficient freedom of decision.
Requirements	none

Courses	Kind	Subject	Group size	SWS	Workload [h]
	2 Excursions	Workflow in companies and institutions from life sciences	1	1	90

Examinations	Prüfungsform(en)	graded/ungraded
	None	Ungraded

Requirements for admission to exam	None	graded/ungraded
Miscellaneous		

Modul: **Insights in the workflow of life science companies 2**				UNIVERSITÄT BONN
Module Number LIMES-006	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Joachim Schultze			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)		WP	2.
Learning objective	Students should get insights into basic work routines, operational procedures, organizational structures and employment opportunities for scientists with a master's or PhD degree in molecular and systems immunology or related life science degrees in general and particular in respect to organizations focusing on immune system-related products or services. They will learn about research and development of life science products and services in industry directly from representatives of selected companies that agreed to present themselves within the master program.			
Skills	Being able to understand, classify and judge the employment opportunities for scientists with a master's or PhD degree in molecular and systems immunology or related life science degrees in industry or other areas within the private sector (e.g. funding agencies, foundations, non-profit organizations, etc.) Understanding the principles of research and development in the life science sector with an emphasis on 'red' biotechnology, pharma, medical engineering, and the life science software industry sectors. Know the key research and development approaches and their applications within these companies.			
Content	Students will get the opportunity to visit one selected organization within the private sector to get insights into how these organizations operate, how they are organized, and what the working conditions are. An emphasis will be research and development within these organizations. Additionally, they will attend one interactive workshop with company representatives from research and development, strategic management, marketing or sales, students will get to know the basic aspects of products, services and the research and development leading to these products Students will also get the opportunity to discuss issues concerning industrial research and development, products, services and sales with representatives of the respective companies providing the workshops.			
Requirements	none			

Courses	Kind	Subject	Group size	SWS	Workload [h]
	1 Excursion	Workflow in companies and institutions from life sciences	1	1	45
	1 Seminar	Workflow in companies and institutions from life sciences	22		45

Examinations	Prüfungsform(en)	graded/ungraded
	None	Ungraded
Requirements for admission to exam	None	graded/ungraded
Miscellaneous		

Modul: **Insights in the workflow of life science companies 3**				UNIVERSITÄT BONN
Module Number LIMES-007	Workload 90	CP 3	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Joachim Schultze			
Providing institution	LIMES-Institute			

	Study course	Category	Semester
	Biochemistry (MSc) Immunobiology: from molecules to integrative systems (MSc)	WP	2.

Learning objective	Students will learn about research and development of life science products and services in industry directly from representatives of selected companies that agreed to present themselves within the master program.
Skills	Understanding the principles of research and development in the life science sector with an emphasis on 'red' biotechnology, pharma, medical engineering, and the life science software industry sectors. Know the key research and development approaches and their applications within these companies. Being able to read, understand and present fundamental issues in the area of research and development of the respective company.
Content	Students will attend two interactive workshops with company representatives from research and development, strategic management, marketing or sales, students will get to know the basic aspects of products, services and the research and development leading to these products Students will also get the opportunity to discuss issues concerning industrial research and development, products, services and sales with representatives of the respective companies providing the workshops.
Requirements	none

Courses	Kind	Subject	Group size	SWS	Workload [h]
	2 Seminars	Workflow in companies and institutions from life sciences	22	1	90

Examinations	Prüfungsform(en)	graded/ungraded
	None	Ungraded
Requirements for admission to exam	None	graded/ungraded
Miscellaneous		

Modul: **Labrotation 1: Biochemistry and chemical biology**				UNIVERSITÄT BONN
Module Number Biochem-005	Workload 360 h	CP 12	Duration (weeks) 8	Cycle Every semester
Representative	Prof. Dr. Thorsten Lang			
Institution	LIMES-Institute			
	Study Course		Category	Semester
	Biochemistry (MSc)		WP	2.
Learning Objective	Students should acquire hands-on experience in scientific research by joining ongoing research projects in the working groups of Biochemistry or chemical biology at the LIMES Institute. They should be able to design, conduct and evaluate specific biochemical experiments. The project should be presented in a written report in analogy to a scientific publication, including an informative introduction, comprehensive and logical presentation of the data, as well as a critical discussion and interpretation of the results in light of the relevant literature.			
Skills	Experimental skills in state-of-the-art techniques used in biochemistry and chemical biology; ability to design scientific experiments and to critically evaluate scientific data; Soft skills in written and oral presentation of scientific results; ability to work in a team.			
Content	The scientific topic of the lab rotation always lies within the scientific scope of the supervisor. By this means, an optimal supervision can be guaranteed.			
Requirements				

Courses	Kind	subject	group size	SWS	Workload [h]
	Laboratory course	Biochemistry or chemical biology	1	8	360

Examinations		Graded/Ungraded
	- Publication-like written summary of results obtained, data interpretation and discussion - Lab course	- Graded (40%) - Graded (60%)

Requirements for admission to exam		Graded/Ungraded
	Lab journal regular participation Data presentation in the group seminar	ungraded ungraded ungraded
miscellaneous		

Modul: **Labrotation 1: Biophysics and Physiology**				UNIVERSITÄT BONN
Module Number Biochem-006	Workload 360 h	CP 12	Duration (weeks) 8	Cycle Every semester
Representative	Prof. Dr. Thorsten Lang			
Institution	LIMES-Institute			
	Study Course		Category	Semester
	Biochemistry (MSc)		WP	2.
Learning Objective	Students should acquire hands-on experience in scientific research by joining ongoing research projects in the working groups of Biophysics or Physiology at the LIMES Institute. They should be able to design, conduct and evaluate specific scientific experiments. The project should be presented in a written report in analogy to a scientific publication, including an informative introduction, comprehensive and logical presentation of the data, as well as a critical discussion and interpretation of the results in light of the relevant literature.			
Skills	Experimental skills in state-of-the-art techniques; ability to design scientific experiments and to critically evaluate scientific data; Soft skills in written and oral presentation of scientific results; ability to work in a team.			
Content	The scientific topic of the lab rotation always lies within the scientific scope of the supervisor. By this means, an optimal supervision can be guaranteed.			
Requirements				

Courses	Kind	subject	group size	SWS	Workload [h]
	Laboratory course	Biochemistry	1	8	360

Examinations		Graded/Ungraded
	- Publication-like written summary of results obtained, data interpretation and discussion - Lab course	- Graded (40%) - Graded (60%)

Requirements for admission to exam		Graded/Ungraded
	Lab journal regular participation Data presentation in the group seminar	ungraded ungraded ungraded
miscellaneous		

Modul: **Chemical Biology**				UNIVERSITÄT BONN
Module Number Biochem-007	Workload 180	CP 6	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Gunther Mayer			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc)		P	3.
Learning objective	Students should learn the principles of Chemical Biology and underlying chemical, biological and molecular working mechanisms. They also learn the relevant methodology applied in the field.			
Skills	Understanding the principles of Chemical Biology. Know the key methods and their applications. Be able to read, understand and present fundamental issues in Chemical Biology.			
Content	Chemical Biology of different compound classes (e.g. proteins, nucleic acids, small molecules), target structures and model organisms (e.g. bacteria, eukaryotic cells, animals). Basic principles of Chemical Biology, basic methods on synthesizing compounds (nucleic acids, proteins, peptides), investigation and characterization of molecular properties of small molecules and macromolecules, measuring molecular interactions in vitro, in cells, and in vivo.			
Requirements	none			
Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Chemical Biology	40	2	90
	Tutorial			1	45
	Seminar			1	45
Examinations	Prüfungsform(en)			graded/ungraded	
	Written exam			Graded	
Requirements for admission to exam	Participation to seminars			graded/ungraded	
				ungraded	
Miscellaneous					

Modul: **Physiology**				UNIVERSITÄT BONN
Module Number Biochem-008	Workload 180	CP 6	Duration 1 Semester	cycle annual
Representative	Prof. Dr. Michael Pankratz			
Providing institution	LIMES-Institute			
	Study course		Category	Semester
	Biochemistry (MSc)		P	3.
Learning objective	Students should learn how cells function in different cellular contexts and the interplay between different tissue and organ systems.			
Skills	Understanding basic principles in neural, endocrine and metabolic systems in health and disease			
Content	Basic organization and comparison of nervous system in different organisms, tools to study function and structure of neural circuits, neuropeptides and hormonal control of physiology. Molecular basis of cellular regulation of lipid homeostasis and pathophysiology of lipid metabolism and animal models to study metabolic diseases.			
Requirements	none			

Courses	Kind	Subject	Group size	SWS	Workload [h]
	Lecture	Physiology	40	2	90
	Tutorial			1	45
	Seminar			1	45

Examinations	Prüfungsform(en)	graded/ungraded
	Written exam	Graded
Requirements for admission to exam	Participation to seminars	graded/ungraded ungraded
Miscellaneous		

Modul: **Oral examination Master of Biochemistry**				UNIVERSITÄT BONN
Module Number Biochem-009	Workload 180 h	CP 6	Duration (weeks)	Cycle annual
Representative	Prof. Dr. Thorsten Lang			
Institution	LIMES-Institute			
	Study Course		Category	Semester
	Biochemistry (MSc)		P	3.
Learning Objective	Students should acquire profound and comprehensive knowledge on biochemical topics, making interconnections between the contents of individual modules on biochemistry.			
Skills	Profound knowledge on biochemistry Making interconnections between different areas of biochemistry			
Content	Oral examination on content and interconnection of modules Biochem-004, Biochem-005, Biochem-015 and Biochem-016			
Requirements	Biochem-001, 002, 007, 008			
Courses	Kind	subject	group size	SWS	Workload [h]
	Examination	Cellular Biochemistry, Chemical Biology, Biophysics, Physiology	1		180
Examinations				Graded/Ungraded	
	Oral exam			graded	
Requirements for admission to exam				Graded/Ungraded	
miscellaneous					

Modul: **Labrotation 2: Biochemistry and chemical biology**				UNIVERSITÄT BONN
Module Number Biochem-010	Workload 360 h	CP 12	Duration (weeks) 8	Cycle Every semester
Representative	Prof. Dr. Thorsten Lang			
Institution	LIMES-Institute			
	Study Course		Category	Semester
	Biochemistry (MSc)		WP	3.
Learning Objective	Students should acquire hands-on experience in scientific research by joining ongoing research projects in the working groups of Biochemistry or chemical biology at the LIMES Institute. They should be able to design, conduct and evaluate specific biochemical experiments. The project should be presented in a written report in analogy to a scientific publication, including an informative introduction, comprehensive and logical presentation of the data, as well as a critical discussion and interpretation of the results in light of the relevant literature.			
Skills	Experimental skills in state-of-the-art techniques used in biochemistry and chemical biology; ability to design scientific experiments and to critically evaluate scientific data; Soft skills in written and oral presentation of scientific results; ability to work in a team.			
Content	The scientific topic of the lab rotation always lies within the scientific scope of the supervisor. By this means, an optimal supervision can be guaranteed.			
Requirements				

Courses	Kind	subject	group size	SWS	Workload [h]
	Laboratory course	Biochemistry or Chemical Biology	1	8	360

Examinations		Graded/Ungraded
	- Publication-like written summary of results obtained, data interpretation and discussion - Lab course	- Graded (40%) - Graded (60%)

Requirements for admission to exam		Graded/Ungraded
	Lab journal regular participation Data presentation in the group seminar	ungraded ungraded ungraded
miscellaneous		

Modul: **Labrotation 2: Biophysics and Physiology**				UNIVERSITÄT BONN
Module Number Biochem-011	Workload 360 h	CP 12	Duration (weeks) 8	Cycle Every semester
Representative	Prof. Dr. Thorsten Lang			
Institution	LIMES-Institute			
	Study Course		Category	Semester
	Biochemistry (MSc)		WP	3.
Learning Objective	Students should acquire hands-on experience in scientific research by joining ongoing research projects in the working groups of Biophysics or Physiology at the LIMES Institute. They should be able to design, conduct and evaluate specific scientific experiments. The project should be presented in a written report in analogy to a scientific publication, including an informative introduction, comprehensive and logical presentation of the data, as well as a critical discussion and interpretation of the results in light of the relevant literature.			
Skills	Experimental skills in state-of-the-art techniques; ability to design scientific experiments and to critically evaluate scientific data; Soft skills in written and oral presentation of scientific results; ability to work in a team.			
Content	The scientific topic of the lab rotation always lies within the scientific scope of the supervisor. By this means, an optimal supervision can be guaranteed.			
Requirements				

Courses	Kind	subject	group size	SWS	Workload [h]
	Laboratory course	Biophysics, Physiology	1	8	360

Examinations		Graded/Ungraded
	- Publication-like written summary of results obtained, data interpretation and discussion - Lab course	- Graded (40%) - Graded (60%)

Requirements for admission to exam		Graded/Ungraded
	Lab journal regular participation Data presentation in the group seminar	ungraded ungraded ungraded
miscellaneous		

<table>
<tr><td colspan="4">Modul:
Master Thesis</td><td>UNIVERSITÄT BONN</td></tr>
<tr><td>Module Number
Biochem-012</td><td>Workload
750 h</td><td>CP
30</td><td>Duration
1 Semester</td><td>Cycle
Every semester</td></tr>
<tr><td>Representative</td><td colspan="4">Prof. Dr. Thorsten Lang</td></tr>
<tr><td>Providing Institution(s)</td><td colspan="4">LIMES Institute</td></tr>
<tr><td></td><td colspan="2">Study Course</td><td>Category</td><td>Semester</td></tr>
<tr><td></td><td colspan="2">Biochemistry (MSc)</td><td>P</td><td>4.</td></tr>
<tr><td>Learning objective</td><td colspan="4">Aim of the master thesis is to demonstrate how scientific questions can be answered using experimental approaches. They will collect and get an overview of project-relevant literature and identify the remaining open scientific questions for a specific topic. They will develop experimental strategies to answer these questions and plan and conduct own experiments. They will apply the state of the art methodology and will gather hands-on experience using these techniques. During these experiments, the students will learn which (positive and negative) controls should be included in their experiments and which conclusions can (and cannot) be drawn from a given experimental setup. They will design an experiment in such a way that a correct and precise answer to a specific question can be given. They will interpret scientific experiments and, given a specific result from their experiments, identify the next steps to continue the project.
During the implementation of their master thesis, the students are supervised by a principle investigator from the hosting group.
At the end of their thesis, students will describe their project in a scientific way. Students will write a master thesis, from which the text part is in between 30 and 80 pages including

A title, which should be focused but still should contain all project-relevant information
An abstract, in which the scientific topic, the most important findings and resulting conclusions will be summarized briefly.
An introduction, in which general information to understand the scientific project is provided, an overview of the current literature is given and the aim of the study is pointed out clearly
A material and methods section, in which the experimental procedures are explained precisely
The results of the scientific project, presented in clear and accurate figures
A discussion, in which the results are interpreted and in which is described, which consequences can be drawn from the project
A reference section, in which all cited literature is listed
</td></tr>
<tr><td>Skills</td><td colspan="4">

Planning and implementation of a scientific project
Design of scientific experiments
Hand-on experience in state-of-the-art methodology
Collecting and interpretation of project-relevant literature
Interpretation of obtained results
Generation of clear and informative figures
Detailed report of experimental protocols
</td></tr>
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<tr><td></td><td colspan="5">

Writing of a scientific report
Extracting the most important information for a summary
Pointing out the impact of the obtained results for the scientific community

</td></tr>
<tr><td>Content</td><td colspan="5">The scientific topic of the master thesis always lies within the scientific scope of the supervisor. By this means, an optimal supervision can be guaranteed.</td></tr>
<tr><td>Requirements</td><td colspan="5">Minimum 60 CP</td></tr>
<tr><td rowspan="2">Courses</td><td>Kind</td><td>Subject</td><td>Group Size</td><td>SWS</td><td>Workload [h]</td></tr>
<tr><td>Master Thesis</td><td>Individual research project</td><td>1</td><td></td><td>750</td></tr>
<tr><td rowspan="2">Examination</td><td colspan="3"></td><td colspan="2">Graded/ungraded</td></tr>
<tr><td colspan="3">Evaluation of the Master Thesis by two examiners</td><td colspan="2">graded</td></tr>
<tr><td rowspan="2">Requirements for admission to exam</td><td colspan="3" rowspan="2">Attendance of at least 20 scientific talks in the field of biomedicine</td><td colspan="2">Graded/ungraded</td></tr>
<tr><td colspan="2">ungraded</td></tr>
<tr><td>Miscellaneous</td><td colspan="5"></td></tr>
</table>