Module Catalogue

for the Master Degree Programme

Microbiology (M.Sc.)

Status: 2016

Faculty of Biology and Pharmacy

List of abbreviations

cp	credit point(s)
L	Lecture
S	Seminar
E	Exercise
P	Practical course
EX	Excursion
SS	Summer Semester
WS	Winter Semester
hpw	hours per week
Mc	Module coordinator

Study Programme Master Microbiology

The study programme lists the modules and their credit points. The modules are described in detail in the module catalogue, where the distribution of work loads and examination types are specified. A record sheet is given to allow the student to track their personal study course and to check success.

During the first semester, three basic modules are completed. In substantiated cases, the Examinations Committee can allow the exchange of one of the basic modules by one of the regular elective modules.

If individual compulsory elective modules with 5 credit points are chosen, the necessary 10 credits can be achieved by combination of two modules.

The advanced modules are elective modules of own choice. For setting priorities also combinations of topics are offered: Physiology of Bacteria (2.2, 2.3, 2.7), Mycology (2.5, 2.9, 2.10), Plant-Microbe Interactions (2.7, 2.9, 2.13, 2.15), Biotechnology (2.2, 2.3, 2.10) and Human Pathogens (2.10, 2.11, 2.12, 2.17).

Modules from other degree programmes will be included after mandatory mentors advise if they particularly enhance the interdisciplinary character of the study course. Examples could be – aside from modules of biological and biochemical programmes (e.g. offered within the Master Programme Molecular Life Sciences or in Systematic Botany) – specifically Bioethics, Scientific English, Nanotechnologies, (Bio)Geosciences or Optics.

Study stays abroad within the Master degree programme Microbiology are both possible and desired. For the support of students, who want to go abroad, a special entry on the website publishes links to the International Office, the Erasmus Programme, the networking amongst Coimbra Universities, current links (such as RISE) and the offer of an individual mentoring.

Module nummer	Module name	Credit points
1st Semester	3 Basic modules	
MMB1.1	Basic module “Energy Metabolism of Bacteria“	10
MMB1.2	Basic module “Molecular Genetics and Physiology of Communication in Fungi“	10
MMB1.3	Basic module “Microbial Interactions“	10
MMB1.4	Basic module „Microbiology and Molecular Biology"	10
2nd Semester	30 ECTS from the advanced modules offered	
MMB2.2	Advanced module “Biotechnology of Fermentation Processes “	10
MMB2.3	Advanced module “Degradation of Natural Products and Xenobiotics“	10
MMB2.4	Advanced module “Microbial Genetics and Molecular Biology of Fungi“	10
MMB2.5	Advanced module “Methods and Techniques in Microbial Genetics and Microbiology“	10
MMB2.7	Advanced module “Soil microbiomes and biofilms“	10
MMB2.9	Advanced module “Cell Biology and Communication in Basidiomycetes”	10
MMB2.10	Advanced module “Molecular Biology/Biotechnology/Infection Biology of Lower Eukaryotes”	10
MMB2.11	Advanced module “Molecular and Microbial Infection Biology”	5
MMB2.12	Advanced module “Immune Reactions of Humans to Microorganisms and Pathogens”	5
MMB2.13	Advanced module “Biomolecular Chemistry”	5
MMB2.14	Advanced module “Aquatic Geomicrobiology”	5
MMB2.15	Advanced module “Chemical Ecology“	5
MMB2.17	Advanced module „Translational Medical Microbiology“	5
3rd Semester	2 Modules	
MMB3.1	Project module	15
MMB3.2	Specialization module	15
4th Semester	Master thesis	
MMB4	Master thesis	30

Record sheet M.Sc. Microbiology

Module	**Work performed**	**Grade**	**Signature**
Basic module 1	Lecture/Exercise		
	Practical course		
	Seminar		
	Microbiological Colloquium		
Basic module 2	Lecture/Exercise		
	Practical course		
	Seminar		
	Microbiological Colloquium		
Basic module 3	Lecture/Exercise		
	Practical course		
	Seminar		
	Microbiological Colloquium		
Advanced module 1			
(module of own choice from the modules of microbiology offered)			
Advanced module 2			
(module of own choice from the modules of microbiology offered)			
Advanced module 3			
(of own choice from the modules of microbiology and biological subsidiary subjects offered)			
Project module	Oral exam		
	Practical work		
Specialization module	Poster presentation		
	Practical work		
Mentor programme	1st Semester	-	
Mentor programme	2nd Semester	-	
Mentor programme	3rd Semester	-	
Mentor programme	4th Semester	-	

1st Semester: 3 Basic modules (30 cp)

MMB1.1: Energy Metabolism of Bacteria (Mc: Diekert) **G**			WS/SS	hpw	**cp**
L	Ecology and Physiology of Bacteria	Diekert	SS	2	
P	Ecology and Physiology of Bacteria	Diekert, Nüske, Schubert, Studenik	WS	4 weeks block	
S	History of Microbiology	Diekert	WS	1	
S	Microbial Communication Colloquium	Wöstemeyer, Diekert, Kothe, Brakhage	WS	partially	
				8	**10**

MMB1.2: Molecular Genetics and Physiology of Communication in Fungi (Mc: Wöstemeyer) **G**			WS/SS	hpw	**cp**
L	Molecular Communication in Fungi	Wöstemeyer	WS	2	
P	Molecular Genetics and Physiology of Communication in Fungi	Wöstemeyer, Wetzel	WS	4 weeks	
S	Molecular Genetics and Physiology of Communication in Fungi	Wöstemeyer	WS	1	
S	Microbial Communication Colloquium	Wöstemeyer, Diekert, Kothe, Brakhage	WS	partially	
				8	**10**

MMB1.3: Microbial Interactions (Mc: Kothe) **G**			WS/SS	hpw	**cp**
L	Microbial Interactions	Kothe	WS	2	
P	Microbial Interactions	Kothe, Krause et al.	WS	4 weeks	
S	Microbial Interactions	Kothe, Krause et al.	WS	1	
S	Microbial Communication Colloquium	Wöstemeyer, Diekert, Kothe, Brakhage	WS	partially	
				8	**10**

MMB 1.4: Microbiology and Molecular Biology (Mv: Brakhage) **G**			WS/SS	hpw	**cp**
V	Molecular Biology	Brakhage	WS	2	
S	Molecular Biology	Brakhage, Heinekamp et al.	WS	1	
P	Molecular Biology	Brakhage, Heinekamp et al.	WS	5	
S	Microbial Communication Colloquium	Diekert, Wöstemeyer, Kothe, Brakhage	WS	partially	
				8	**10**

***2nd semester:* Advanced modules (30 cp compulsory elective):**

MMB2.2: Biotechnology of Fermentation Processes (Mc: Diekert) **A**			WS/SS	hpw	**cp**
S	Current Topics in Environmental Microbiology	Diekert	SS (WS)	2	
P	Biotechnology of Fermentation Processes	Nüske	SS	3 weeks block	
E	Practise of Physical Measurement Methods	Nüske	SS	1	
				8	**10**

MMB2.3: Degradation of Natural Products and Xenobiotics (Mc: Diekert) **A**			WS/SS	hpw	**cp**
L	Microbial Degradation of Natural Products and Xenobiotics	Diekert	SS	2	
S	Microbial Degradation of Natural Products and Xenobiotics	Diekert	SS (WS)	2	
P	Microbial Degradation of Natural Products and Xenobiotics	Schubert, Studenik	SS	3 weeks block	
				9	**10**

MMB2.4: Microbial Genetics and Molecular Biology (Mc: Wöstemeyer) **A**			WS/SS	hpw	**cp**
L	Molecular Biology and Genetics of Fungi	Wöstemeyer	SS	2	
E	Cloning Strategies in Pro- und Eukaryotes	Wöstemeyer	SS	2	
L	Genetics and Molecular Biology of Bacteriophages and Viruses	Wöstemeyer	SS	2	
S	Fungal Genetics	Wöstemeyer, Wetzel	SS	2	
S	Genetical Colloquium	Theißen, Wöstemeyer, and others	SS/WS	partially	
				8	**10**

MMB2.5: Methods and Techniques in Microbial Genetics and Microbiology (Mc: Wöstemeyer) **A**			WS/SS	hpw	**cp**
L/E	Experimental Techniques in Molecular and Microbial Genetics	Wöstemeyer	SS	2	
L/S	Radioisotopes in Biology	Wöstemeyer	SS	2	
P	Practical course in Molecular Biology	Wetzel, Wöstemeyer	SS	2 weeks block	
S	Methods and Techniques in Microbiology and Genetics	Wetzel	SS	1	
	* two weeks full time starting 1 week after end of the lecture period in WS; seminar to the practical course			9	**10**

MMB2.7: Soil microbiomes and biofilms (Mc: Kothe) **A**			WS/SS	hpw	**cp**
S	Soil microbiomes and biofilms	Krause, Kovacs	SS	2	
E	Soil microbiomes and biofilms	Krause, Kovacs	SS	1	
P	Soil microbiomes and biofilms	Krause, Kovacs	SS	3 weeks block	
				8	**10**

MMB2.9: Cell Biology and Communication of Basidiomycetes (Mc: Kothe) **A**			WS/SS	hpw	**cp**
L/E	Mushrooms	Dörfelt	SS	2	
S	Cell Biology and Communication of Basidiomycetes	Krause	SS	1	
P	Cell Biology and Communication of Basidiomycetes	Krause	SS	3 weeks block	
				8	**10**

MMB2.10: Molecular Biology/Biotechnology/Infection Biology of Lower Eukaryotes (Mc: Brakhage) **A**			WS/SS	hpw	**cp**
L	Molecular Biology/Biotechnology of Lower Eukaryotes	Brakhage	SS	2	
S	Molecular Biology/Biotechnology of Lower Eukaryotes	Brakhage	SS	2	
P	Molecular Biology/Biotechnology of Lower Eukaryotes	Brakhage	SS	2 weeks block	
				8	**10**

MMB2.11: Molecular and Microbial Infection Biology (Mc: Hube) **A**			WS/SS	hpw	**cp**
L	Molecular and Microbial Infection Biology	Hube	SS	2	
S	Seminar	Hube	SS	1	
P	Molecular and Microbial Infection Biology	Hube	SS	1 week block	
				4	**5**

MMB2.12: Immune Reactions of Humans to Microorganisms and Pathogens (Mc: Zipfel) **A**			WS/SS	hpw	**cp**
L/S	Immune Reactions of Humans to Microorganisms and Pathogens	Zipfel	WS	2	
S	Seminar	Zipfel	SS	1	
P	Immune Reactions of Humans to Microorganisms and Pathogens	Zipfel	SS	1 week block	
				4	**5**

MMB2.13: Biomolecular Chemistry (Mc: Hertweck) **A**			WS/SS	hpw	**cp**
L	Biomolecular Chemistry	Hertweck	SS	2	
S	Seminar	Hertweck	SS	1	
P	Biomolecular Chemistry	Hertweck	SS	1 week block	
				4	**5**

MMB2.14: Aquatic Geomicrobiology (Mc: Küsel) **A**			WS/SS	hpw	**cp**
L	Microbiology of Aquatic Ecosystems	Küsel	WS	2	
S	Seminar	Küsel	SS	1	
P	Microbial Ecology	Küsel	SS	1 week block	
				4	**5**

MMB2.15: Chemical Ecology (Mc: Boland) **A**			WS/SS	hpw	**cp**
L	Chemical Ecology	Kost	SS	2	
S	Seminar and combined lecture	Kost	SS	2	
				4	**5**

MMB 2.17: Translational Medical Microbiology (Mv: Kurzai) **A**			WS/SS	hpw	**cp**
L	Translational Medical Microbiology	Kurzai	SS	2	
P	Practical course	Kurzai	SS	2	
				4	**5**

3rd semester: ***2 Modules (30 cp)***

MMB3.1: Project module MMB (Mc: supervisor) **T**			WS/SS	hpw	**cp**
P		according to agreement	WS/SS		
				20	**15**

MMB3.2: Specialization module MMB (Mc: supervisor) **T**			WS/SS	hpw	**cp**
P		according to agreement	WS/SS		
				20	**15**

4th semester: Master thesis (30 cp)

MMB4: Master thesis MB (Mc: supervisor) **T**			WS/SS	hpw	**cp**
P	Master thesis MB	according to agreement	WS/SS		
				40	**30**

G: Basic module (compulsory)
A: Advanced module (compulsory elective)
T: Thesis (Master thesis)

Module descriptions

Module number	MMB1.1
Module name	**Energy Metabolism of Bacteria**
Module coordinator	Diekert
Admission requirements	None
Usability (required for)	Advanced modules, Project and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory module: Basic module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	Practical course 4 weeks, half-time, L 2 hpw; S to the practical courses, Microbiological Colloquium bi-weekly (participation in 2 semesters)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	The lecture "Ecology and Physiology of Bacteria" deals with selected pathways of energy metabolism in bacteria with special focus on ecological aspects. In the practical course, fermentation will be studied with the help of chemical/ physical methods of analysis. The results of the practical courses are summarized in protocols. History of microbiology topics are presented in the seminar talks. The Microbiological Colloquium is attended in combination with the other basic modules during the two semesters and questions to the colloquium are answered in the introductions to the practical courses.
Learning and qualification objectives	Survey of selected pathways of energy metabolism in bacteria with special regard to element cycles (L); cultivation and cell fractionation of strictly anaerobic bacteria; gas chromatography und enzymatic-photometric test methods; protein purification and –characterization (P); presentation (S); overview of actual topics in microbiology (Colloquium). *Regular participation in the practical course and the colloquium is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation in the practical courses and the Microbiological Colloquium, seminar talk (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written examination (50 %), protocols to the practical courses (50 %)

Module number	MMB1.2
Module name	**Molecular Genetics and Physiology of Communication in Fungi**
Module coordinator	Wöstemeyer
Admission requirements	None
Usability (required for)	Advanced modules, Project and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory module: Basic module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	L (2 hpw), P (4 weeks, half-time), S to the practical course (1hpw), Microbiological Colloquium bi-weekly (participation in 2 semesters)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	The focus is set on the developmental biology of fungi.The practical work units comprise the molecular basis of communication as well as cloning and expression studies on genes involved in fungal developmental programmes. In the theoretical courses, genetics and developmental biology of all groups of fungi and their specific communication systems are dealt with by means of appropriate models.
Learning and qualification objectives	Survey of developmental biology and genetics of fungi; planning, realization, protocolation and presentation of experiments, presentation of original papers and in depth elaboration of relevant content; training in experimental skills in physiology and molecular biology. *Regular participation in the practical course and the colloquium is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation in the practical courses and Microbiological Colloquium; protocols
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination (100%)

Module number	MMB1.3
Module name	**Microbial Interactions**
Module coordinator	Kothe
Admission requirements	None
Usability (required for)	Advanced modules, Project and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory module: Basic module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	Practical course 2 weeks (block); L 2 hpw; S to the practical courses, Microbiological Colloquium bi-weekly (participation in 2 semesters)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 165 h - 135 h
Contents	Basic microbiology and molecular biology techniques (including -omics technologies) are introduced and investigation of secondary metabolites is shown. Subjects of study in the practical course are fungal genetics of basidiomycete fungi, ectomycorrhiza and metal resistance and interactions with filamentous streptomycete Bacteria. The Microbiological Colloquium is attended in combination with the other basic microbiological modules during 2 semesters. Questions to the colloquium are answered in the introduction to the practical courses.
Learning and qualification objectives	Knowledge and skills in microbiology; presentation of results in the form of publications as training for the compilation of the Master´s thesis; presentation of original papers in the form of a seminar talk. *Regular participation in the practical course and the colloquium is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation in the practical course and Microbiological Colloquium, seminar talk (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Protocols to the practical courses (100 %)

Module number	MMB1.4
Module name	**Microbiology and Molecular Biology**
Module coordinator	Brakhage
Admission requirements	None
Usability (required for)	Advanced modules, Project and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory module: Basic module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	Practical course 4 weeks, half-time; L 2 hpw; S to the practical courses, Microbiological Colloquium bi-weekly (participation in 2 semesters)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	Basic molecular biology and microbiology with a stronghold in fungal GMOs is presented. Different transformation and mutant characterization techniques are learned. The potential of microbes for secondary metabolite production is shown with the example of *Aspergillus nidulans* penicillin biosynthesis.
Learning and qualification objectives	Basic knowledge and skills in molecular biology and microbiology. Presentation of scientific publications in the form of a seminar talk. *Regular participation in the practical course and the colloquium is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation in the practical course and Microbiological Colloquium, seminar talk (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Protocols to the practical courses (100 %)

Module number	MMB2.2
Module name	**Biotechnology of Fermentation Processes**
Module coordinator	Diekert
Admission requirements	1 Basic module
Usability (required for)	Project module and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	Practical course (block: generally 2 weeks, full-time); S 2 hpw; exercises (physical measuring methods coupled to the practical course)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	Bacteria and fungi are cultivated in fermenters of different sizes. Different techniques of fermentation are carried out and the theoretical knowledge necessary is given. In the seminars, original papers on current topics of Microbiology are reviewed. In the exercises, the fundamental principles of fermentation technology and the measurement techniques necessary for it are discussed and trained.
Learning and qualification objectives	Batch-, fed-batch- and continuous fermentation, measuring and control technology (P); fundamentals of measuring and control technology (E); presenting original papers (S). *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation in the practical course. Seminar talk (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written exam (50 %), protocol to the practical course (50 %)

Module number	MMB2.3
Module name	**Degradation of Natural Products and Xenobiotics**
Module coordinator	Diekert
Admission requirements	1 Basic module
Usability (required for)	Project module and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar,	L (2 hpw), practical course (block: generally 3-4 weeks, half-time); exercise in scientific publishing
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	The lecture “Degradation of natural products and xenobiotics“ deals with the aerobic and anaerobic degradation of natural products and xenobiotics by bacteria and fungi. Special degradation abilities of anaerobic bacteria are investigated in the practical course. The results are summarized in a protocol and in the form of a scientific publication according to international standards and discussed thereafter.
Learning and qualification objectives	Survey of microbial degradation capacities (L); different chromatographic methods for the detection of metabolites, biochemical characterization of specific catabolic enzymes, analysis of encoding genes (P); preparation of a paper according to international standards (E). *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation in the practical course, seminar talk (passed), protocol to the practical course (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Report in style of a publication (100 %)

Module number	MMB2.4
Module name	**Microbial Genetics and Molecular Biology**
Module coordinator	Wöstemeyer
Admission requirements	1 Basic module
Usability (required for)	Project module and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	L (2 x 2 hpw), E 2hpw, S (2 hpw), Genetic Colloquium (2 semesters attendance)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	The module provides a survey of fundamental properties of the organisms treated and deepens especially the knowledge of genetics of pro- and eukaryotes. Experimental strategies are demonstrated and trained. Students learn to know and understand differentiation and regulation concepts and work out functioning laboratory strategies for the cloning of phages, as well as pro- and eukaryotic microorganisms.
Learning and qualification objectives	Molecular physiology and biology of fungi, planning, presentation and discussion of cloning experiments; study and presentation of original publications. *Regular participation in the exercise and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written examination (75%), Seminar talk (25%)

Module number	MMB2.5
Module name	**Methods and Techniques in Microbial Genetics and Microbiology**
Module coordinator	Wöstemeyer
Admission requirements	1 Basic module
Usability (required for)	Project module and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar,	L (2 hpw), P (2 weeks full-time), S to the P, E (2 hpw)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 135 h - 165 h
Contents	The module teaches techniques in the fields of microbial molecular biology and genetics. In the practical course the fundamental methods of DNA cloning, gene expression analysis in heterologous systems, and of analytics on RNA-, DNA- and protein levels are treated. The practical work is complemented by theoretical courses designed for high practical relevance. The exercises focus on the use of radioisotopes in biological experiments.
Learning and qualification objectives	Application of molecular biological techniques; planning and design of experiments; recherche techniques; management and presentation of research projects; text analysis and reviewing publications; writing scientific texts. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Integrative paper as module examination (100%)

Module number	MMB2.7
Module name	**Soil microbiomes and biofilms**
Module coordinator	Kothe
Admission requirements	1 Basic module
Usability (required for)	Project module and Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar,	P (3 weeks half-time), S to the P (2 hpw)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 130 h - 170 h
Contents	The fundamentals of taxonomy and systematics with special emphasis on identification are treated. Isolates originating from environmental samples are treated as examples and identified with all methods available to develop fundamental skills important for the job market for microbiologists. The practical skills are supported by database analyses which also train the theoretical knowledge. In the seminar, the methods are deepened and work plans for the following practical course are developed.
Learning and qualification objectives	The soil microbiome and the understanding of principles governing community structure are given. The ecological relevance and genetic control of biofilm formation are investigated. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation, preparation of seminar subjects (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Protocol to the practical course (100 %)

Module number	MMB2.9
Module name	**Cell Biology and Communication in Basidiomycetes**
Module coordinator	Kothe
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar,	Practical course and seminar (3 weeks half-time), L or E
Credit points (ECTS credits)	10
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	The lecture introduces higher fungi of the group of dikarya. This research focussed practical course is directed at approaches, which can be used for a master´s thesis in each part of microbiology. Molecular mechanisms of cell biology and fundamentals of communication in fungi are treated, e. g. the phenotypic characterization of transformants which overexpress mutant proteins of intracellular signal transduction. Methods of gene identification and database analysis are trained. The sexual differentiation and pheromone answer in fungi are studied in detail. Signal perception and translation into cell biological developmental programmes are investigated with the help of integration in current research projects. The mechanisms and genetic regulation processes in establishing ectomycorrhizae are examined.
Learning and qualification objectives	The focussing on research topics is trained. Recent original papers are selected and presented to train data handling and presentation techniques. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation, seminar talk (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Protocol to the practical course (100 %)

Module number	MMB2.10
Module name	**Molecular Biology/Biotechnology/Infection Biology of Lower Eukaryotes**
Module coordinator	Brakhage
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semesters
Module composition/ Forms of instruction (lecture, seminar,	L 2 hpw, S 2 hpw, P (generally 14 days full-time)
Credit points (ECTS credits)	10 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 150 h - 150 h
Contents	Molecular biology (gene regulation, signal transduction, genomics) of eukaryotic microorganisms; biotechnology of the production of proteins, antibiotics, amino acids; combinatorial biosynthesis, secondary metabolism. Transcriptome and proteome analysis.
Learning and qualification objectives	Overview and deepened knowledge of molecular biology, genomics and biotechnology of fungi. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written exam to the lecture (70%), protocols to the practical course (30 %)

Module number	MMB2.11
Module name	**Molecular and Microbial Infection Biology**
Module coordinator	Hube
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar,	L/S (2 hpw), P (generally 1 week, full-time)
Credit points (ECTS credits)	5 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 75 h - 75 h
Contents	Molecular biology, microbiology andinfection biology of human-pathogenic yeasts. Growth, morphology, cellular structure, metabolism, molecular genetic manipulation,gene expression and virulence factors of pathogenic yeasts, interaction with host cells.
Learning and qualification objectives	Overview and deepened knowledge of molecular biology / microbiology / infection biology of human pathogenic fungi. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written exam (60 %), seminar talk, experimental execution and protocols (40 %)

Module number	MMB2.12
Module name	**Human Immune Reactions to Microorganisms and Pathogens**
Module coordinator	Zipfel
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester
Module composition/ Forms of instruction (lecture, seminar,	L/S (2 hpw), P (generally 1 week, full-time)
Credit points (ECTS credits)	5 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 60 h - 90 h
Contents	Immune reactions of humans against microorganisms and pathogens, immune evasion of pathogens and microorganisms, genetic susceptibility for infections, methods in immune and infection biology
Learning and qualification objectives	Overview and deepened knowledge of immune biology, molecular biology, infection biology. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written exam (70%), protocols or talk (30 %)

Module number	MMB2.13
Module name	**Biomolecular Chemistry**
Module coordinator	Hertweck
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters
Module composition/ Forms of instruction (lecture, seminar,	L/S (2 hpw), P (generally 1 week full-time)
Credit points (ECTS credits)	5 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 75 h - 75 h
Contents	Biology and chemistry of natural compounds from microorganisms, structures of natural compounds, biosyntheses, screening methods, chemical analysis and molecular biological analysis of biosynthesis genes
Learning and qualification objectives	Overview and deepened knowledge of the biology and chemistry of natural compounds from microorganisms. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation; knowldge of the lecture in winter semester is required (can be accepted alternatively)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral exam (100 %)

Module number	MMB2.14
Module name	**Aquatic Geomicrobiology**
Module coordinator	Küsel
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	2 semesters (WS, SS)
Module composition/ Forms of instruction (lecture, seminar,	L (2 hpw in WS), S (1 hpw in SS), P (1 week full-time during semester break)
Credit points (ECTS credits)	5 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 85 h - 65 h
Contents	The module deals with the importance of microbial processes in aquatic habitats. The lecture will give an overview about the origin of life on early Earth, the evolution of metabolic diversity and the interaction of microbes with minerals. We will also highlight the importance of recently discovered processes like anaerobic methane oxidation or annamox in marine and freshwater ecosystems. In the seminar and practical course, specific microbial processes in an aquatic habitat will be studied with biogeochemical methods in the field and molecular analyses.
Learning and qualification objectives	Importance of microorganisms for element cycles during 4 billions of years; overview of the current research in marine and freshwater microbiology, overview of methods in limnochemistry. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Written exam (50 %), seminar talk and protocol (50 %)

Module number	MMB2.15
Module name	**Chemical Ecology**
Module coordinator	Boland
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester (WS, SS)
Module composition/ Forms of instruction (lecture, seminar,	L (2 hpw) and S/P (2 hpw)
Credit points (ECTS credits)	5 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 60 h - 90 h
Contents	Ecological and evolutionary theory of interactions, molecular mechanisms of evolution, levels of selection, individuality, and the evolution of cooperation. The evolution of sex and life-histories.
Learning and qualification objectives	A basic understanding of fundamental (chemical) ecological and evolutionary principles and concepts with a particular focus on microorganisms. Participants will practice to introduce a complex topic. *Regular participation in the practical course and the seminar is required to reach the study objectives of the module. The teaching staff will inform about further details at the beginning of the courses.*
Admission requirements for the module examination	Regular participation
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral test (50 %), seminar talk (50 %)

Module number	MMB2.17
Module name	**Translational Medical Microbiology**
Module coordinator	Kurzai
Admission requirements	1 Basic module
Usability (required for)	Project module, Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory elective module: Advanced module
Frequency of offer (module cycle)	Yearly
Duration of module	1 semester (SS)
Module composition/ Forms of instruction (lecture, seminar, exercise, practical course)	L (2 hpw), practical course (1 week block)
Credit points (ECTS credits)	5 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 70 h - 80 h
Contents	The lecture introduces infectious diseases and human immune reactions with examples from bacterial, fungal and viral pathogens, probiotics, antibiotics resistances and vaccine development as well as new diagnostic techniques. Microscopy, live cell imaging, host-pathogen interactions, cell biology and disinfection/sterilization techniques as well as detection of antibodies are practiced.
Learning and qualification objectives	Infectious diseases, immune response and detection of human pathogenic microorganisms.
Admission requirements for the module examination	Test (passed)
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination at the end of practical course (100 %)

Module number	MMB3.1
Module name	**Project Module**
Module coordinator	Diekert, Wöstemeyer, Kothe, Brakhage, Küsel, Hube
Admission requirements	2 Basic modules, 1 Advanced module
Usability (required for)	Specialization module
Type of module (compulsory, compulsory elective module)	Compulsory module
Frequency of offer (module cycle)	Each semester (WS, SS)
Duration of module	1 semester (half of the semester, full-time)
Module composition/ Forms of instruction (lecture, seminar,	Practical labwork
Credit points (ECTS credits)	15 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 300 h - 150 h
Contents	The module serves as preparation for the Master thesis by carrying out research within a current research project. The module contains an oral exam about the field of microbiology. It is expected, that the project module is completed at the institution where the Master thesis is planned.
Learning and qualification objectives	Preparing and independently carrying out research projects; orientation to research topics; integrative sight on microbiological topics
Admission requirements for the module examination	none
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Oral examination on the entire field of microbiology (30 min.) by one of the module coordinators (100 %)

Module number	MMB3.2
Module name	**Specialization Module**
Module coordinator	Diekert, Wöstemeyer, Kothe, Brakhage, Küsel, Hube
Admission requirements	2 Basic modules, 1 Advanced module
Usability (required for)	Master thesis
Type of module (compulsory, compulsory elective module)	Compulsory module
Frequency of offer (module cycle)	Each semester (WS, SS)
Duration of module	1 semester (half of the semester, full-time)
Module composition/ Forms of instruction (lecture, seminar,	Practical labwork
Credit points (ECTS credits)	15 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 300 h - 150 h
Contents	In the module, a research area is selected and the technical preparation of the Master thesis is performed. The tutorial research work contains elaboration of literature data and experimental lab work on a special topic of microbiology, that is part of the current research work of the institution offering the module.
Learning and qualification objectives	Advanced techniques; orientation on research subject
Admission requirements for the	none
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Poster presentation (100 %)

Module number	MMB4.1
Module name	**Master thesis**
Module coordinator	Diekert, Wöstemeyer, Kothe or Brakhage
Admission requirements	60 cp
Usability (required for)	-
Type of module (compulsory, compulsory elective module)	Compulsory module
Frequency of offer (module cycle)	Yearly (WS, SS)
Duration of module	1 semester (full-time)
Module composition/ Forms of instruction (lecture, seminar,	Practical lab work
Credit points (ECTS credits)	30 cp
Workload in hours: - in class and - self-study (incl. examination preparation)	 - 700 h - 200 h
Contents	The Master thesis demonstrates that the student is able to solve a problem in the field of microbiology within 6 months independently with scientific methods. The subject of the Master thesis is supervised by one of the module coordinators and must be cleared with him. Great importance is attached to carefully collecting, evaluating and interpreting data. The module trains the independent writing of a scientific paper and leads to self-dependent scientific work.
Learning and qualification objectives	Independent development and evaluation of an experiment as well as writing a scientific paper.
Admission requirements for the	none
Requirements for the award of credit points (forms of examination, weighting of grades in %)	Master thesis (100 %)