Modulhandbuch

Microbiology - Master's Programme

im Wintersemester 2021/2022

erstellt am 03/12/21

Mastermodule

mar500 - Physiology and diversity of microorganisms

Module label	Physiology and diversity of microorganisms
Module code	mar500
Credit points	12.0 KP
Workload	360 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Könneke, Martin (Module responsibility) der Mikrobiologie, Lehrende (Module counselling)
Prerequisites	none
Skills to be acquired in this module	The students know the cells of pro- und eukaryotes. They understand the basic mechanisms of microbial metabolism. They know the physiological and phylogenetic groups of prokaryotes, eukaryotic microorganisms and viruses. They have an overview over applied aspects of microbiology.
Module contents	Lecture + Exercises: Physiology and Life modes of Prokaryotes: Cellular and subcellular organization, assimilation and dissimilation, energy metabolism, transport, microbial growth, respiration, chemiosmotic theory, fermentation, anaerobic respiration, lithotrophy, photosynthesis, prokaryotic diversity, systematics and taxonomy, Archaea, Bacteria, Eukarya, pathogenic prokaryotes, evolution, microbiological techniques Lecture + Exercises: Microbial Diversity The eukaryotic cell, diversity, systematics and taxonomy of prokaryotes and eukaryotic microorganisms , algae, protozoa, fungi, slime molds, phagocytosis, symbioses, pathogenic eukaryotes, diversity of eukaryotic microbes, components of viruses, virus reproduction, bacteriophages, diversity of viruses, virus diseases Broadening lectures, one out of the following lectures: - Biological significance of suspended matter) - Sediment Microbiology This lecture presents state of the art knowledge about occurrence, life and activities of microorganisms in these environments. Physiological issues are addressed as well as evolutionary and applied aspects. Topics are: • Formation, diagenesis and special features of sediments • physico-chemical conditions and geological records • interpretation of gradients • microbes and biological processes in sediments • methods for cultivation of sediment organisms • molecular methods • biogeochemical methods • quantification of prokaryotes and viruses (Teacher: Engelen; Form of study/semester periods per week: 4 week block, 2 lectures per week, Presence: 16 hours, private study: 74 hours; Credits: 3; 2nd Semester, Learning target/competences: Physico-chemical conditions, microbial processes and methods of studying these processes in sediments) Broadening Seminar: Scientific writing and presentation The students know the importance and structure of scientific publications. They have learned to critically read those, and know the requirements of different parts. They are trained to to give oral presentations and know how to produce scientific reports and posters. The know how to use the library and how to find relevant literature on the internet, and how to use data banks like Endnote. They have learned how to present themselves for an application. Seminar Scientific writing and presentation: - Types and relevance of scientific publications - Parts of scientific publications step by step: - Abstract, Introduction, Results, Discussion - University facilities for literature search - Oral presentation - How to prepare posters - Tips for using PowerPoint, Word and Endnote - Job application (Courses: Seminar (2 SPPW, 3 CP); Teachers: Engelen; Work load: Presence: 30 hours, private study: 60 hours; Passing criteria: Oral presentation or discussion of parts of scientific papers) - alternative lectures of the MSc MUWI or Biology program (see current online schedule) Excursions to companies and scientific institutions
Reader's advisory	Brock. Microbiology
Links	

Language of instruction	English
Duration (semesters)	2 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel / module level	
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	Lecture + Exercises: Physiology and life modes of prokaryotes (2 + 1 semester periods per week [SPPW], 3 CP) Lecture + Exercises: Microbial diversity (2 + 1 SPPW, 3 CP) 1x broadening lecture or seminar (Biological significance of suspended matter / Sediment microbiology / Scientific writing and presentation) (2 SPPW, 3 CP) Microbiological + ICBM Colloquium (2 CP) Excursions (1 CP)
Vorkenntnisse / Previous knowledge	None

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period.	Two written tests about the contents of the lectures 'Physiology and life modes of prokaryotes' and Microbial Diversity. At least 50 % of the reachable points in written tests about the two lectures mentioned above.

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		6		84
Exercises		2		28
Study trip		1		14
Total time of attendance for the module				126 h

mar510 - Molecular Mechanisms and Interactions

Module label	Molecular Mechanisms and Interactions
Module code	mar510
Credit points	12.0 KP
Workload	360 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	der Mikrobiologie, Lehrende (Module counselling) Rabus, Ralf Andreas (Module responsibility)
Prerequisites	none
Skills to be acquired in this module	The students know the molecular mechanisms of metabolism, genetics and evolution. They know regulatory mechanisms on the molecular level and feedback mechanisms between organisms. They know the basics of microbial ecology and the biogeochemistry of important microbial habitats. They know molecular and chemical-analytical methods of microbiology. The have experience with the field study of microorganisms.
Module contents	Lecture + exercises: Molecular Microbiology Part I on DNA: structure, DNA-proteins, DNA-replication, recombination, transposition, mutation, repair, plasmids and DNA-exchange Part II on gene expression: transcription, regulation of transcription, translation Part III on enzymes: protein structures, basic concepts and kinetics, catalytic and regulatory strategies Part IV on regulatory networks: diauxie and catabolite repression, oxygen regulation, chemotaxis Lecture + exercises: Microbial Ecology Principles of biogeochemistry, global element cycles, mineralization of organic substances, chemotaxis, aquatic habitats, terrestrial habitats, deep subsurface biosphere, syntrophy and symbiosis, microbes in earth history, methods in microbial ecology, isotope fractionation, applied microbiology, bioremediation Broadening Lecture: Scientific writing and presentation Presentation and analysis of structure und style of scientific publications, presentation and discussion of own written elaborations Excursions into the field
Reader's advisory	Molecular Microbiology : Stryer – Biochemistry Voet – Biochemistry Knippers – Molekulare Genetik Snyder – Molecular Genetics of Bacteria Brock - Microbiology
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	12 CP | VL; Ü; KO; EX | 2. FS | Rabus
Modullevel / module level	---
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Lecture + Exercises: Molecular microbiology, (2 +1 SPPW, 3 CP) Lecture + Exercises: Microbial ecology (2 + 1 SPPW, 3 CP) Broadening lecture: Scientific writing and presentation (2 SPPW, 3 CP) Excursion (1 CP) Microbiological + ICBM Colloquium (2 CP)
Vorkenntnisse / Previous knowledge	none

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period, the exact date will be announced during the course.	Two written tests about the contents of the lectures 'Molecular Microbiology' and 'Microbial Ecology'. At least 50 % of the reachable points in written tests about the two lectures mentioned above. Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		4		56
Exercises		2		28
Seminar		2		28
Study trip		1		14
Total time of attendance for the module				126 h

mar520 - Main Module Proteomics

Module label	Main Module Proteomics
Module code	mar520
Credit points	12.0 KP
Workload	360 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Rabus, Ralf Andreas (Module responsibility) Wöhlbrand, Lars (Module counselling) N., N. (Module counselling)
Prerequisites	Lecture: Physiology and diversity of prokaryotes Lecture: Molecular Microbiology
Skills to be acquired in this module	The students are getting directly involved in actual scientific projects in the area of physiological and/or meta-proteomics (under guidance). They • get acquainted with state-of-the-art proteomic concepts and technologies, • know how to write concise scientific protocols, • know how to present/discuss their results in public.
Module contents	Functional proteomics: Daily lectures introduce the students to theory and concepts of modern proteomics: (i) separation of cellular compartments and protein extraction, (ii) gel-based and -free protein separation, (iii) gel-staining, protein detection and quantification by image analysis, (iv) integrative mass spectrometry-based protein identification, (v) meta-proteomics, and (vi) focused genomic analysis. Each student will prepare a seminar presentation on selected publications relevant for the actual scientific project. The following sequence of experiments will be conducted: - extraction and quantification of total protein from prepared cell samples (incl. separation of compartments), - protein separation by SDS-PAGE and staining with Coomassie, silver and/or fluorescent dyes, - digital image acquisition and analysis, - manual and/or automated band excision, - protein identification by nanoLC-ESI-MS/MS, - nanoLC-MALDI-coupling and protein identification by MALDI-TOF-MS/MS, - Physiological interpretation of predicted protein functions and relevant genomic context.
Reader's advisory	Lottspeich - Bioanalytik
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	yearly
Module capacity	unlimited
Reference text	12 CP | SE; PR | 2. FS | Rabus
Modullevel / module level	
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	Seminar (2 CP), practical course (10 CP)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	Announced at the beginning of the course.	One assessments of examination: Portfolio: Written protocol and contribution to the seminar (seminar presentation) Seminar presentation (25%), written protocol (75 %). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice or the course.

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2		28
Practical training		8		112
Total time of attendance for the module				140 h

mar530 - Main Module Ecophysiology of anaerobes

Module label	Main Module Ecophysiology of anaerobes
Module code	mar530
Credit points	12.0 KP
Workload	360 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Könneke, Martin (Module responsibility) Engelen, Bert (Module counselling) der Mikrobiologie, Lehrende (Authorized examiners)
Prerequisites	Lecture: Microbial Physiology and Diversity, recommended: Sediment Microbiology
Skills to be acquired in this module	The students can contribute to current scientific projects (under guidance). They know modern analytical techniques. They know and understand recent scientific literature. They can write scientific reports, present their results and discuss them in the public.
Module contents	“Ecophysiology of prokaryotes”: Projects derived from current scientific programs are carried out, typically in groups of two students guided by a senior scientist or PhD student. Typical project deal with: - Anaerobic processes - Molecular analysis of microbial communities - Sediment microbiology - Physiological experiments and activity measurements - Impact of viruses - Microscopic analysis of chemotaxis In the accompanying seminar, recent scientific studies in international journals are presented by the students. The results are summarized and discussed in a protocol fulfilling scientific level requirements.
Reader's advisory	will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	12 CP | SE; PR | 1. FS | Cypionka
Modullevel / module level	
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Block course, 4 weeks, seminar and laboratory work
Vorkenntnisse / Previous knowledge	Lecture: Physiology and diversity of prokaryotes; recommended: Sediment microbiology

Examination	Time of examination	Type of examination
Final exam of module	Announced during the course.	One assessments of examination: Portfolio: Written protocol and contribution to the seminar (seminar presentation) Seminar presentation (no mark), written protocol (100%) Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice or the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2		28
Practical training		8		112
Total time of attendance for the module				140 h

mar540 - Main Module Ecology of Marine Microbial communities

Module label	Main Module Ecology of Marine Microbial communities
Module code	mar540
Credit points	12.0 KP
Workload	360 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Simon, Meinhard (Module responsibility) Brinkhoff, Thorsten Henning (Module counselling)
Prerequisites	Lecture: Biological significance of suspended matter
Skills to be acquired in this module	The students learn how to address scientific questions and to carry out experimental and/or field work in scientific projects guided by experienced researchers and PhD students. The projects are designed in the context of ongoing research on the ecology of bacterial communities in the water column, oxic sediments and associated to eukaryotic organisms. The students learn to apply various state of the art methods and approaches in aquatic microbial ecology and how to interpret data and results of the projects. They learn to write protocols in the structure of scientific papers and to present own results and reference studies to an audience. The students gain competences in how to design experiments and address specific research questions in aquatic microbial ecology and to choose appropriate methods. They obtain practical experience in project-targeted application of state of the art methods. This enables them to obtain a more critical view on the application of these and other methods and on the validity of scientific investigations in aquatic microbial ecology.
Module contents	“Ecology of marine microbes”: The students carry out small projects coming out of ongoing research of PhD Thesis work and other current research of the working group. Typically a group of two of three students is guided by a senior researcher and/or a PhD student. In the accompanying seminar, recent scientific studies published in international journals are presented by the students. The results are written down and discussed in a protocol fulfilling scientific level requirements.
Reader's advisory	will be announced
Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	12 CP | SE; PR | 2. FS | Simon
Modullevel / module level	
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	Lecture: Biological significance of suspended matter

Examination	Time of examination	Type of examination
Final exam of module	to be announced during the course.	One assessments of examination: Portfolio: Written protocol and contribution to the seminar (seminar presentation) Assessments of examination: Portfolio: Written protocol (75 %) and contribution to the seminar (seminar presentation 25%). Active participation in the course. This includes, e.g. specific exercises, writing a lab report and seminar presentation, according to the advice of the supervisors.

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		9		126
Total time of attendance for the module				140 h

mar550 - Profile Module Physiology of bacteria

Module label	Profile Module Physiology of bacteria
Module code	mar550
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Könneke, Martin (Module responsibility) Engelen, Bert (Module counselling)
Prerequisites	Lecture: Physiology and diversity of prokaryotes
Skills to be acquired in this module	The students know how to • cultivate bacteria and generate pure cultures • determine the live count • prepare and use washed cell suspensions for experiments • measure bacterial activity (respiration, proton translocation, transport processes) and growth • use and understand the functioning electrodes (pH, O2) and photometers • use a microscope and take digital microphotographs • quantitatively rely growth, energy metabolism and fundamental physiological processes • understand the action of inhibitors • present and discuss scientific results • write a scientific protocol
Module contents	Physiology of bacteria: The course starts with an introductory seminar every morning. One enrichment and isolation experiment will be performed over 10 days. Four physiological experiments are done over two day´s round robin. The following processes are analyzed: Growth under oxic and anoxic conditions, respiration with complex and monomer substrates, respiration-driven proton translocation, transport of ions.
Reader's advisory	will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	6 CP | SE; PR | 1. or 3. FS | Cypionka
Modullevel / module level	
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)
Vorkenntnisse / Previous knowledge	Lecture: Physiology and diversity of prokaryotes

Examination	Time of examination	Type of examination
Final exam of module	Will be announced during the course	One assessment of examination: Portfolio (seminar presentation, written protocol) Protocol (100 %), seminar presentation (no mark). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar560 - Profile Module Fermentation

Module label	Profile Module Fermentation
Module code	mar560
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Rabus, Ralf Andreas (Module responsibility) Wöhlbrand, Lars (Module counselling)
Prerequisites	Lecture: Physiology and diversity of prokaryotes (successfully completed) Lecture: Molecular Microbiology
Skills to be acquired in this module	The students are getting directly involved in actual scientific projects in the area of general physiology (under guidance). They understand the scientific rational and design of the experiment(s), get acquainted with state-of-the-art concepts and technologies for process-controlled cultivation and growth balancing, know how to write concise scientific protocols, know how to present/discuss their results in public.
Module contents	“Fermentation”: Daily lectures introduce the students to theory and concepts of process-controlled cultivation: (i) growth physiology and balancing, (ii) design and operating mode of laboratory fermenters, (iii) pH / pO2 electrodes and kLa-determination of O2-supply, (iv) on-line gas analysis (O2, CO2, etc.) by mass spectrometry. Each student will prepare a seminar presentation on selected publications relevant for the actual scientific project. The following sequence of experiments will be conducted: -cultivation of bacterial pure cultures in Erlenmeyer flasks as inoculum for actual “fermenter”-cultures -determination of optical density, the live count and dry weight of cells during cultivation in fermenter -(dis)assembly and sterilization of fermentation devices -operate process-controlled fermenters (incl. O2 and pH adjustments and sterile sampling) -determine O2-consumption and CO2-production rates based on on-line GC-MS measurements -quantitative determination and calculation growth balances
Reader's advisory	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	6 CP | SE; PR | 2. FS | Rabus
Modullevel / module level	
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Seminar (1 SPPW); practical course (4 SPPW)
Vorkenntnisse / Previous knowledge	Lecture: Physiology and diversity of prokaryotes (successfully completed); Lecture: Molecular Microbiology

Examination	Time of examination	Type of examination
Final exam of module	Announced at the beginning of the course.	One assessment of examination: Portfolio (seminar presentation, written protocol) Protocol (100 %), seminar presentation (no mark). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar570 - Profile Module Introduction to DNA-sequencing and sequence analysis

Module label	Profile Module Introduction to DNA-sequencing and sequence analysis
Module code	mar570
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Brinkhoff, Thorsten Henning (Module responsibility) Moraru, Liliana Cristina (Module counselling)
Prerequisites	Lecture during the course
Skills to be acquired in this module	The students know how to • sequence DNA by Sanger sequencing • assemble DNA sequences • use internet databases for sequence comparison • use the various facilities of the NCBI database • analyze bacterial genomes for presence of specific genes • use ARB, databases and literature data to create • phylogenetic trees • design primers and probes • present and discuss scientific results • write a scientific protocol
Module contents	Introduction into DNA-sequencing and sequence analysis: The course starts with a lecture on the first two days. During the following days the participants will give seminar talks about different scientific studies for which DNA sequencing was highly relevant. DNA sequencing will be taught in the lab of the working group. Sequence analysis, introduction into the use of various internet databases and the phylogeny program ARB will be demonstrated by individual use of laptops of the institute.
Reader's advisory	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	6 CP | SE; PR | 1. or 3. FS | Brinkhoff
Modullevel / module level	
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Seminar (1 SPPW); practical course (4 SPPW)
Vorkenntnisse / Previous knowledge	Lecture during the course

Examination	Time of examination	Type of examination
Final exam of module	Announced during the course.	One assessment of examination: Portfolio (seminar presentation, written protocol) Protocol (75 %), seminar presentation (25 %). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar580 - Profile Module Microbial ecology of marine sediments

Module label	Profile Module Microbial ecology of marine sediments		
Module code	mar580		
Credit points	6.0 KP		
Workload	180 h		
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule		
Responsible persons	Könneke, Martin (Module responsibility) Engelen, Bert (Module counselling)		
Prerequisites	Lecture: Microbial ecology		
Skills to be acquired in this module	The students know how to • sample marine sediments • characterize the cores sedimentologically and biogeochemically • collect and analyze porewater • determine total cell counts • quantify groups of organisms molecular biologically • cultivate different physiological groups of bacteria • present and discuss scientific results • write a scientific protocol		
Module contents	Microbial ecology of marine sediments: The physiological diversity of microorganisms and their spatial distribution within marine sediments are demonstrated according to chemical and physical parameters. Different physiological groups are analysed along the sediment column of intertidal sandflat or beach. Sediment sampling is performed at the back barrier area of the island 'Spiekeroog' at the beginning of the course. Oxygen penetration, porewater sulfate and methane concentrations are measured down to a depth of app. 5 meters. As microbiological parameters, total cell numbers are counted and the numbers of archaea and bacteria are calculated after quantitative PCR (qPCR). More specifically, the relative amounts of sulfate reducers and methanogens are also determined by qPCR targeting key-genes for sulfate reduction and methanogenesis. Furthermore, every single group of students will specifically enrich one physiological type of microorganisms from distinctive sediment layers. Microbial growth and activity are monitored over the whole period of the course. Accompanying the course, all participants will give a talk to introduce 'their' physiological group concerning its ecology, physiology, and strategies for a specific enrichment. All the data and observations of the single groups will be combined at the end of the course to draw an overall picture of microbial diversity and the occurrence of the different physiological groups corresponding to relevant geochemical gradients.		
Reader's advisory			
Links			
Language of instruction	English		
Duration (semesters)	1 Semester		
Module frequency	jährlich		
Module capacity	unlimited		
Reference text	6 CP | SE; PR | 2. FS | Engelen		
Modullevel / module level			
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht		
Lehr-/Lernform / Teaching/Learning method	Block course, 2 weeks, seminar and laboratory work		
Vorkenntnisse / Previous knowledge	Lecture: Microbial ecology and Lecture: Sediment microbiology		
Examination	Time of examination	Type of examination	
Final exam of module	Announced during the course.	One assessment of examination: Portfolio (seminar presentation, written protocol) Protocol (100 %), seminar presentation (no mark). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)	

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar600 - Profile Module Methods in Aquatic Microbial Ecology

Module label	Profile Module Methods in Aquatic Microbial Ecology
Module code	mar600
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Simon, Meinhard (Module responsibility) Brinkhoff, Thorsten Henning (Module counselling)
Prerequisites	For the practical course lecture: Methods in Aquatic Microbial Ecology
Skills to be acquired in this module	The students learn to: • Analyze bacterial substrates at ambient concentrations such as dissolved amino acids and carbohydrates by high performance liquid chromatography (HPLC), organic carbon by TOC and POC/PON analyser and the composition of the pool of dissolved organic matter by Fourier-Transform Ion Cyclotron Resonance Mass spectrometry (FT-ICR-MS). • Determine bacterial cell numbers by flow cytometry and epifluorescence microscopy and to analyse these data by image analysis. • Extract bacterial DNA from water and sediment samples. • to amplify bacterial genes by specific primers and PCR. • Assess bacterial communities by culture-independent methods such as denaturing gradient gel electrophoresis. • present and discuss scientific results • write a scientific protocol • The students gain competences in: • Understanding how to analyse dissolved substrates of heterotrophic aquatic bacterial communities by state of the art approaches. • How to assess the abundance of aquatic bacterial communities by state of the art approaches. • Analyzing the composition of bacterial communities by PCR-based culture-independent approaches.
Module contents	Methods in Aquatic Microbial Ecology: The course starts with a lecture introducing basic issues of aquatic microbial ecology with an emphasis on methodological aspects. This lecture is completed before the practical work starts. During the practical course of a block of two weeks the participants carry out analyses and experiments on: • determining the concentration of dissolved organic substrates (amino acids, carbohydrates, dissolved and particulate organic carbon), • the abundance of bacterial communities in aquatic systems • The composition of bacterial communities in environmental samples by denaturing gradient gel electrophoresis (DGGE) of 16S rRNA targeted gene fragments. The main emphasis is on analyses and approaches of bacterial communities in the water column.
Reader's advisory	Lecture notes, available on Stud.IP
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	6 CP | SE; PR | 1. or 3. FS | Simon
Modullevel / module level	
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)
Vorkenntnisse / Previous knowledge	For the practical course lecture: Methods in Aquatic Microbial Ecology

Examination	Time of examination	Type of examination
Final exam of module	Will be announced during the course.	One assessment of examination: Portfolio (seminar presentation, written protocol) Protocol (100 %), seminar presentation (no mark). Active participation (Active and documented

Examination	Time of examination	Type of examination
		participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar610 - Profile Module Isolation and characterization of microorganisms

Module label	Profile Module Isolation and characterization of microorganisms
Module code	mar610
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Könneke, Martin (Module responsibility) Engelen, Bert (Module counselling)
Prerequisites	Microbial Physiology and diversity (M1)
Skills to be acquired in this module	In this course the students will isolate bacteria and other microorganisms. They will learn classical microbiological techniques as enrichment culture, aseptic work, preparation of liquid and solid media, cultivation under oxic and anoxic condition, on agar plates and in deep agar dilution, description of microbes by techniques as staining, microscopy, microphotography.
Module contents	Isolation and characterization of microorganisms: Seminar Prior to the laboratory work the participants shall read literature about first isolation, description and current studies on their target organisms and present this and their isolation strategy in the seminar. During the course and at the end, results and a possible molecular identification of isolates will be presented and discussed. Practical work: Every student prepares media and agar plates required for the isolation of the different target organisms. If pure cultures have been isolated, they should be transferred to long-term storage on agar and in liquid nitrogen. Sampling sites and different stages of the enrichment and isolation are documented by macro- and microphotography and described in the report. Finally, tests to verify purity of the culture and its identification, as well as a phylogenetic analysis are requested.
Reader's advisory	Brock. Biology of Microorganisms / Cypionka, Grundlagen der Mikrobiologie / Drews, G. Mikrobiologisches Praktikum, 1974 / DSMZ catalogue (www.dsmz.de) / Dyer, B.D. A field guide to the bacteria. 2003 /Praktikumsskripte, Uni Göttingen, Uni Konstanz / Reddy, C.A. Methods for general and molecular Microbiology. 2007 / Steinbüchel et al. Mikrobiologisches Praktikum. 2012 / www.microbiogical-garden.net
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	6 CP | SE; PR | 1. or 3. FS | Cypionka
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Seminar and laboratory work, twice per week, half a day each
Vorkenntnisse / Previous knowledge	Module mar500 including lectures on “Physiology and life modes of prokaryotes” and “Microbial diversity”

Examination	Time of examination	Type of examination
Final exam of module	Announced during the course.	One assessment of examination: Portfolio (seminar presentation, written protocol) Protocol (100 %), webpage, seminar presentation (no mark). . Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar620 - Profile Module Marine Chemical Ecology

Module label	Profile Module Marine Chemical Ecology
Module code	mar620
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Rohde, Sven (Module counselling) Schupp, Peter (Module responsibility)
Prerequisites	Lecture: Organic chemistry
Skills to be acquired in this module	Students will learn about the chemical properties and major ecological roles of secondary metabolites, how to investigate the secondary metabolites of marine invertebrates and algae, how to analyze secondary metabolite profiles, how to isolates compounds of interest and how to conduct various bioassays to assess potential ecological roles of crude extracts and potentially isolated compounds. Students will also learn how to statistically evaluate their results.
Module contents	Chemical Ecology: The course consists of lectures, followed by laboratory experiments. Students will research about various topics in marine chemical ecology. Laboratory work will include production of extracts from various invertebrates and algae. Extracts will be tested in various feeding assays to assess the chemical properties of extracts. Extracts will also be tested for antimicrobial activity with environmental strains. This includes the culture of test bacteria and antimicrobial assays. Final evaluation will be a laboratory report about the experiments. This will include statistical analysis of their experiments and discussion of their results in the framework of the lectures and seminars presented during the course.
Reader's advisory	Marine Chemical Ecology, McClintock, Baker
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	Compact Course, Seminar, Practical
Vorkenntnisse / Previous knowledge	Lecture: Organic chemistry

Examination	Time of examination	Type of examination
Final exam of module	Will be announced during the course	One assessment of examination: Portfolio (seminar presentation, written protocol) Portfolio (seminar presentation – no mark, written protocol 100%). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar621 - Profile Module Techniques in light microscopy and electron microscopy

Module label	Profile Module Techniques in light microscopy and electron microscopy
Module code	mar621
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Rhiel, Erhard (Module responsibility)
Prerequisites	none
Skills to be acquired in this module	The students will learn • the basics/theory of scanning electron microscopy (SEM) and transmission electron microscopy (TEM) • different sample preparation methods for SEM • to operate our scanning electron microscope • to operate our critical point drying device • to perform sputter coating • to perform negative staining TEM • to operate our transmission electron microscope • to perform immuno-labelling for light microscopy
Module contents	The profile module "Techniques in light microscopy and electron microscopy" runs over a period of 10 days, distributed over three weeks. On the first day, seminars will introduce into the theory, i.e. of SEM and TEM. The remaining 9 days are for practice. The main topics of the course are: basic principles and functioning of light and electron microscopes, sample preparation, fixation, low temperature SEM, low vacuum SEM, negative staining TEM, and immuno-labelling for light microscopy.
Reader's advisory	will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	6 CP | SE; PR | 1. or 3. FS | Rhiel
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	Seminar and laboratory work, at three days for three weeks
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	after delivery of the two course assessments	One assessment of examination: (seminar presentation, poster). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Total time of attendance for the module				70 h

mar630 - Research Project

Module label	Research Project	
Module code	mar630	
Credit points	12.0 KP	
Workload	360 h	
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule	
Responsible persons	Könneke, Martin (Module responsibility) der Mikrobiologie, Lehrende (Module counselling)	
Prerequisites	1 main and 1 profile module	
Skills to be acquired in this module	The students are able to work (under guidance) on an ambitious research project. They understand recent scientific literature and can regard it for their own work. They can prepare, carry out, write down, present and defend their work in the public.	
Module contents	The contents concern variable recent scientific questions on a high scientific level.	
Reader's advisory	project-specific, will be announced	
Links		
Language of instruction	English	
Duration (semesters)	2 Semester	
Module frequency	halbjährlich	
Module capacity	unlimited	
Modullevel / module level	MM (Mastermodul / Master module)	
Modulart / typ of module	Pflicht / Mandatory	
Lehr-/Lernform / Teaching/Learning method	Seminar (2 SPPW); Practical work (4 SPPW)	
Vorkenntnisse / Previous knowledge	1 main module and 1 profile module	

Examination	Time of examination	Type of examination
Final exam of module	Announced during the course.	Two assessments of examination: Written protocol and / or written English thesis, presentation Quality of the scientific performance and thesis (75 %), Final seminar and public defense (25 %). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		6		84
Practical training		12		168
Total time of attendance for the module				252 h

mar640 - Research Project

Module label	Research Project
Module code	mar640
Credit points	12.0 KP
Workload	360 h
Applicability of the module	• Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Könneke, Martin (Module responsibility) der Mikrobiologie, Lehrende (Module counselling)
Prerequisites	1 main and 1 profile module
Skills to be acquired in this module	The students are able to work (under guidance) on an ambitious research project. They understand recent scientific literature and can regard it for their own work. They can prepare, carry out, write down, present and defend their work in the public.
Module contents	The contents concern variable recent scientific questions on a high scientific level.
Reader's advisory	project-specific, will be announced
Links	
Language of instruction	English
Duration (semesters)	2 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	Pflicht / Mandatory
Lehr-/Lernform / Teaching/Learning method	Seminar (2 SPPW); Practical work (4 SPPW)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	Announced during the course.	Two assessments of examination: Written protocol and / or written English thesis, presentation Quality of the scientific performance and thesis (75 %), Final seminar and public defense (25 %).

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		6		84
Practical training		12		168
Total time of attendance for the module				252 h

mar622 - Profile Module R programming for (meta)-genomic sequence analysis

Module label	Profile Module R programming for (meta)-genomic sequence analysis
Module code	mar622
Credit points	6.0 KP
Workload	180 h (Präsenzzeit: 54 Stunden, Selbststudium: 126 Stunden)
Applicability of the module	• Master's Programme Marine Environmental Sciences (Master) > Mastermodule • Master's Programme Microbiology (Master) > Mastermodule
Responsible persons	Moraru, Liliana Cristina (Module responsibility)
Prerequisites	The course „Introduction in sequencing and sequence analysis". Previous programming experience is not required.
Skills to be acquired in this module	DNA sequencing has become a routine method in microbiology research. Most of the times, sequence analysis requires knowledge of a programming language. One of the programing languages most used for this purpose is R. The course will cover the following topics: I. programming in R using an integrated development environment (RStudio) II. working with strings (stringr package) III. working with lists and data frames (readr and dplyr package) IV. sequence analysis (seqinr, Bioconductor packages: Biostrings, GenomicRanges, Decipher) V. (meta)-genomic and data visualization (ggplot2, Gviz) VI. Creating sequence / metadata dabases VII. Accessing and mining sequence / metadata databases though R based web applications (Shiny, DT and Shinyjs packages) VIII. reporting in R (Rmarkdown and Knitr packages) IX. managing code (Roxygen2 package) X. microbial genome annotation using R
Module contents	R programming for (meta)-genomic sequence analysis will run over a two weeks period. A single, introductory lecture will be offered within the first day of the course. Then, the course will be structured in programming exercises which cover all topics at point 12. The exercises are designed to exemplify the use R programming within the framework of microbial (meta)-genome analysis. In addition to the teacher –student sessions, the students will work on individual projects. Each student will receive a short microbial genome (e.g. viral genome), and will analyze it by building custom, self-programmed pipelines. The output from the individual projects will consist in a analysis report prepared in Rmarkdown and Knitr packages. The report will include both the R code and the genome analysis results.
Reader's advisory	will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	15 (Proportionale Aufteilung zwischen Master MUWI und Master Microbiology)
Modullevel / module level	AC (Aufbaucurriculum / Composition)
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	Blockveranstaltung: SE/PR: R programming for (meta)-genomic sequence analysis (4 SWS, 6 KP)
Vorkenntnisse / Previous knowledge	Teilnahme an mar454 Einführung in die DNA-Sequenzierung und Sequenzanalyse. Grundlagen der Programmierung in R, Grundlagen der Molekularen Taxonomie

Examination	Time of examination	Type of examination
Final exam of module	Announced during the course.	Written protocol (80%) and class participation (20%).

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2	SuSe	28
Practical training		2	SuSe	28
Total time of attendance for the module				56 h

Abschlussmodul

mam - Master´s Thesis Module

Module label	Master´s Thesis Module	
Module code	mam	
Credit points	30.0 KP	
Workload	900 h	
Applicability of the module	• Master's Programme Microbiology (Master) > Abschlussmodul	
Responsible persons	Könneke, Martin (Module responsibility) der Mikrobiologie, Lehrende (Module counselling)	
Prerequisites	1 research project	
Skills to be acquired in this module	The students are able to work (under guidance) on an extended research project. They understand recent scientific literature and can regard it for their own work. They can prepare, carry out, write down, present and defend their work in the public.	
Module contents	The contents concern variable recent scientific questions on a high scientific level	
Reader's advisory	project-specific, will be announced	
Links		
Language of instruction	English	
Duration (semesters)	1 Semester	
Module frequency	halbjährlich	
Module capacity	unlimited	
Modullevel / module level		
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht	
Lehr-/Lernform / Teaching/Learning method	Seminar (2 SPPW); Practical work (28 SPPW)	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module		Written English thesis, seminar with public discussion in English According to the examination regulations; quality of the scientific performance and thesis (83.3 %), final seminar and public defense (16.7 %)
Course type	Seminar	
SWS	2	
Frequency		
Workload attendance	28 h	