Modulhandbuch

Microbiology - Master's Programme

im Sommersemester 2019

erstellt am 28/03/24

Modules for Microbiology

Date 28/03/24

Mastermodule

mar500 - Physiology and diversity of microorganisms

Module label	Physiology and diversity of microorganisms
Modulkürzel	mar500
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (module responsibility) • der Mikrobiologie, Lehrende (Module counselling)
Prerequisites	
Skills to be acquired in this module	The students know the cells of pro- und eukaryotes and understand the basic mechanisms of microbial metabolism. Furthermore, students learn about the physiological and phylogenetic groups of prokaryotes, eukaryotic microorganisms and viruses and get an overview on applied aspects of microbiology.
Module contents	**The module consists of 5 parts:** **1) Physiology and life modes of prokaryotes (lecture + exercises)** Topics are cellular and subcellular organisation, assimilation and dissimilation, energy metabolism, transport, microbial growth, chemiosmotic theory, fermentation, anaerobic respiration, lithotrophy, photosynthesis, metabolism of different Archaea, Bacteria pathogenic prokaryotes, microbiological techniques. **2) Microbial diversity (lecture + exercises)** Topics are the eukaryotic cell, diversity, systematics and taxonomy of prokaryotes and eukaryotic microorganisms, algae, protozoa, molds, phagocytosis, symbioses, pathogenic eukaryotes, diversity of eukaryotic microbes, components of viruses, virus reproduction, bacteriophages, diversity of viruses, virus diseases. **3) Broadening lectures, one out of the following** - Biological significance of suspended matter: Lecturer: Simon; Form of study: 1 lecture a week, partially blocked for 2 lectures a week; 3 CP; summer term; - Sediment Microbiology: Lecturer: Engelen; Form of study: 3 weeks block; 3 CP; summer term; 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 - Scientific writing and presentation: Lecturer: Engelen; Form of study: weekly seminar; 3 CP; The students know the importance and structure of scientific publications. They learn to read papers critically and which require important for the different parts. Furthermore, students will train to give oral presentations as well as scientific reports and poste how to use the library and how to find relevant literature and how to use citation programs. Topics are: 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 Excel, PowerPoint, Word and Endnote - Alternative lectures of the MSc “Marine environmental sciences” or “Biology” (see current online schedule)

4) Excursions into the field, to companies and scientific institutions

5) ICBM and microbiological colloquium (alternating weekly)

Literaturempfehlungen	Mardigan “Brock - Biology of microorganisms“
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Type of module	Pflicht / Mandatory
Module level	BC (Basiscurriculum / Base curriculum)
Teaching/Learning method	Lecture + Exercises: Physiology and life modes of prokaryotes (3 CP) Lecture + Exercises: Microbial diversity (3 CP) 1x broadening lecture or seminar (3 CP) Microbiological + ICBM Colloquium (2 CP) Excursions (1 CP)

Examination	Prüfungszeiten	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 '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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		6	SoSe oder WiSe	84
Exercises		2	WiSe	28
Study trip		1	SoSe oder WiSe	14
Präsenzzeit Modul insgesamt				126 h

mar510 - Molecular Mechanisms and Interactions

Module label	Molecular Mechanisms and Interactions
Modulkürzel	mar510
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Rabus, Ralf Andreas (module responsibility) • der Mikrobiologie, Lehrende (Module counselling)
Prerequisites	
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	

The module consists of 5 parts:

1) Molecular Microbiology (lecture + exercise)
Topic I - DNA: structure, DNA-proteins, DNA-replication, recombination, transposition, mutation, repair, plasmids and DNA-exchange
Topic II - gene expression: transcription, regulation of transcription, translation
Topic III - enzymes: protein structures, basic concepts and kinetics, catalytic and regulatory strategies
Topic IV - regulatory networks: diauxie and catabolite repression, oxygen regulation, chemotaxis

2) Microbial Ecology (lecture + exercise)
Principles of biogeochemistry, global element cycles, mineralisation 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

3) Broadening lectures, one out of the following

- Biological significance of suspended matter:
Lecturer: Simon; Form of study: 1 lecture a week, partially blocked for 2 lectures a week; 3 CP; summer term;

- Sediment Microbiology:
Lecturer: Engelen; Form of study: 3 weeks block; 3 CP; summer term;
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

- Scientific writing and presentation:
Lecturer: Engelen; Form of study: weekly seminar; 3 CP;
The students know the importance and structure of scientific publications. They learn to read papers critically and which require important for the different parts. Furthermore, students will train to give oral presentations as well as scientific reports and poste how to use the library and how to find relevant literature and how to use citation programs.

Topics are: 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 Excel, PowerPoint, Word and Endnote

- Alternative lectures of the MSc “Marine environmental sciences” or “Biology” (see current online schedule)

4) Excursions into the field, to companies and scientific institutions

5) ICBM and microbiological colloquium (alternating weekly)

Literaturempfehlungen	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	annual
Module capacity	unlimited
Type of module	Pflicht / Mandatory
Module level	BC (Basiscurriculum / Base curriculum)
Teaching/Learning method	Lecture + Exercises: Molecular microbiology (3 CP) Lecture + Exercises: Microbial ecology (3 CP) Broadening lecture or seminar (3 CP) Excursion (1 CP) Microbiological + ICBM Colloquium (2 CP)

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture period, the exact date will be announced during the course.	**Two assesments of examination:** Written exam on 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		4	SoSe	56
Exercises		2	SoSe	28
Seminar		2	SoSe oder WiSe	28
Study trip		1	SoSe oder WiSe	14
Präsenzzeit Modul insgesamt				126 h

mar520 - Main Module Proteomics

Module label	Main Module Proteomics
Modulkürzel	mar520
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Rabus, Ralf Andreas (module responsibility) • Feenders, Christoph (Module counselling) • Wöhlbrand, Lars (Module counselling)
Prerequisites	
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	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, 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.
Literaturempfehlungen	Lottspeich - Bioanalytik
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Reference text	
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Seminar (2 CP), practical course (10 CP)
Previous knowledge	Lecture: Physiology and diversity of prokaryotes, lecture: Molecular Microbiology

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced at the beginning of the course.	**One assessments of examination:** Portfolio: Written protocol (75%) and contribution to the seminar (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 or the course.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2	SoSe	28
Practical training		8	SoSe	112
Präsenzzeit Modul insgesamt				140 h

mar530 - Main Module Ecophysiology of prokaryotes

Module label	Main Module Ecophysiology of prokaryotes
Modulkürzel	mar530
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (module responsibility) • Engelen, Bert (Module counselling) • der Mikrobiologie, Lehrende (Prüfungsberechtigt)
Prerequisites	
Skills to be acquired in this module	The aim of the module "Ecophysiology of prokaryotes" is to impart in-depth knowledge on the metabolism and physiology of microorganisms and train students in practical skills to measure physiological parameters. After completion of the module, students can - contribute to current scientific projects (under guidance) - know modern analytical techniques - know and understand recent scientific literature - can write scientific reports, present their results and discuss them
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.
Literaturempfehlungen	will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Block course, 4 weeks, seminar and laboratory work
Previous knowledge	Lecture: Physiology and diversity of prokaryotes; recommended: Sediment microbiology

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced during the course.	**One assessments of examination:** Portfolio: Written protocol (100%) and contribution to the seminar (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 or the course supervisor.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2	WiSe	28
Exercises		8	WiSe	112

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Präsenzzeit Modul insgesamt				140 h

mar540 - Main Module Ecology of Marine Microbial communities

Module label	Main Module Ecology of Marine Microbial communities
Modulkürzel	mar540
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Garcia, Sarahi Lorena (module responsibility) • Brinkhoff, Thorsten Henning (Module counselling)
Prerequisites	
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.
Literaturempfehlungen	will be announced
Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	12
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	seminar + pracitical course/exercise

Examination	Prüfungszeiten	Type of examination
Final exam of module	to be announced during the course.	**One 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1	SoSe	14
Exercises		9	SoSe	126
Präsenzzeit Modul insgesamt				140 h

mar560 - Profile Module Fermentation

Module label	Profile Module Fermentation
Modulkürzel	mar560
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Rabus, Ralf Andreas (module responsibility) • Wöhlbrand, Lars (Module counselling)
Prerequisites	
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 growth balancing (e.g. bioreactor), know how to write concise scientific protocols, know how to present/discuss their results in public.
Module contents	"Growth balancing": Daily lectures introduce the students to theory and concepts of growth stoichiometry: (i) aerobic or anaerobic growth experiments in glass vessels and/or bioreactors, (ii) experimental design, (iii) design and operating laboratory fermenters, (iv) HPLC, IC and GC-MS 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: - cultivation of bacterial pure cultures in Erlenmeyer flasks, glass bottles or controlled bioreactors - determination of optical density, the live count, dry weight of cells and microscopic inspection during cultivation - (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 - quantification of substrate consumption for HPLC and IC - quantitative determination and calculation growth balances and efficiencies
Literaturempfehlungen	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	not offered at the moment
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Seminar; practical course
Previous knowledge	Lecture: Physiology and diversity of prokaryotes (successfully completed) Lecture: Molecular Microbiology

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced at the beginning of the course.	**One assessment of examination:** Portfolio: 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
Präsenzzeit Modul insgesamt				70 h

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

Module label	Profile Module Introduction to DNA-sequencing and sequence analysis
Modulkürzel	mar570
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Brinkhoff, Thorsten Henning (module responsibility)
Prerequisites	
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 Genious for genome analysis - 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, the sequence analysis program Genious and the phylogeny programme ARB will be demonstrated by individual use of laptops of the institute.
Literaturempfehlungen	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	18
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Seminar; practical course
Previous knowledge	Lecture during the course

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced during the course.	**One assessment of examination:** Portfolio: 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2	SoSe	28
Exercises		4	SoSe	56
Präsenzzeit Modul insgesamt				84 h

mar580 - Profile Module Microbial ecology of marine sediments

Module label	Profile Module Microbial ecology of marine sediments
Modulkürzel	mar580
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (module responsibility)
Prerequisites	
Skills to be acquired in this module	The students know how to take samples from marine habitats and characterise those biogeochemically and microbiologically. Furthermore, students learn to collect and analyse porewater, determine total cell counts and quantify groups of organisms by molecular methods. Also cultivation of different physiological groups of bacteria will be performed. Finally, scientific results will be presented by the students in a seminar presentation and discussed in a scientific protocol.
Module contents	“SE/PR 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 a sediment column taken at the beach site of the island “Spiekeroog”, which is sampled at the beginning of the course. At this high-energy beach, a submarine groundwater discharge is present, which leads to changing redox and salinity gradients. Therefore, especially anaerobic processes and the influence of seawater infiltration to the beach sediment is investigated. Thus, for example nitrate, sulfate and methane concentrations are measured in porewaters. As microbiological parameters, total cell numbers are counted and the numbers of archaea and bacteria as well as specific physiological groups are determined by using key genes targeted in quantitative PCR (qPCR). Furthermore, every group of students will specifically enrich representatives of a specific phylogenetic group and monitor growth and activity over time. During the accompanying seminar, each participant will give a short talk regarding the metabolic processes, ecology, physiology of a physiologic group. All the data and observations of the individual groups will be combined at the end of the course to provide an overall picture of microbial diversity and the occurrence of the different physiological groups corresponding to geochemical gradients.
Literaturempfehlungen	
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	16
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Block course, 2 weeks, seminar and laboratory work
Previous knowledge	Lecture: Microbial ecology and Lecture: Sediment microbiology

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced during the course.	**One assessment of examination:** Portfolio: 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1	SoSe	14
Exercises		5	SoSe	70
Präsenzzeit Modul insgesamt				84 h

mar600 - Profile Module Methods in Aquatic Microbial Ecology

Module label	Profile Module Methods in Aquatic Microbial Ecology
Modulkürzel	mar600
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Brinkhoff, Thorsten Henning (Module counselling)
Prerequisites	
Skills to be acquired in this module	**Skills to be acquired in this module** The students learn to… · analyse bacterial substrates at ambient concentrations such as dissolved amino acids and carbohydrates by high performance liquid chromatography (HPLC). · 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. · amplify bacterial genes by specific primers and PCR. · assess bacterial communities by culture-independent methods such as denaturing gradient gel electrophoresis and next generation sequencing. · 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. · Analysing the composition of bacterial communities by PCR-based culture-independent approaches.
Module contents	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), · the abundance of bacterial communities in aquatic systems · the composition of bacterial communities in environmental samples by 16S rRNA gene fragments. The main emphasis is on analyses and approaches of bacterial communities in the water column.
Literaturempfehlungen	Lecture notes, available on Stud.IP
Links	
Language of instruction	English

Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Block course, 2 weeks; practical course and seminar
Previous knowledge	For the practical course lecture: Methods in Aquatic Microbial Ecology

Examination	Prüfungszeiten	Type of examination
Final exam of module	Will be announced during the course	**One assessment of examination:** Portfolio: 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1	WiSe	14
Exercises		6	WiSe	84
Präsenzzeit Modul insgesamt				98 h

mar610 - Profile Module Isolation and characterization of microorganisms

Module label	Profile Module Isolation and characterization of microorganisms
Modulkürzel	mar610
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (module responsibility) • Engelen, Bert (Module counselling)
Prerequisites	
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	Prior to the laboratory work the participants shall read literature and current studies about their target group of microorganisms and develop an enrichment strategy isolation. They will present this and their enrichment 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: Student prepares media and agar plates required for the enrichment and isolation of the different target organisms in small groups. The enrichment cultures will be monitored over time by measuring various biological and chemical parameters. If pure cultures have been isolated, they will be analysed microscopically and identified using molecular methods.
Literaturempfehlungen	Brock “Biology of Microorganisms” Cypionka “Grundlagen der Mikrobiologie” Drews “Mikrobiologisches Praktikum” DSMZ catalogue (www.dsmz.de) yer “A field guide to the bacteria” Reddy “Methods for general and molecular Microbiology” Steinbüchel “Mikrobiologisches Praktikum” www.microbiological-garden.net
Links	www.microbiological-garden.net
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Seminar and laboratory work, twice per week, half a day each
Previous knowledge	Module mar500 including lectures on “Physiology and life modes of prokaryotes” and “Microbial diversity”

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced during the course.	**One assessment of examination:** Portfolio: 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.

Examination	Prüfungszeiten	Type of examination

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1	SoSe	14
Exercises		4	SoSe	56
Präsenzzeit Modul insgesamt				70 h

mar620 - Profile Module Marine Chemical Ecology

Module label	Profile Module Marine Chemical Ecology
Modulkürzel	mar620
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Schupp, Peter (module responsibility) • Kellermann, Matthias (Module counselling) • Rohde, Sven (Module counselling)
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.
Literaturempfehlungen	Marine Chemical Ecology, McClintock, Baker
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	AC (Aufbaucurriculum / Composition)
Teaching/Learning method	Compact Course, Seminar, Practical
Previous knowledge	Lecture: Organic chemistry

Examination	Prüfungszeiten	Type of examination
Final exam of module	Will be announced during the course	**One assessment of examination:** 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1	WiSe	14
Practical training		4	WiSe	56
Präsenzzeit Modul insgesamt				70 h

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

Module label	Profile Module R programming for (meta)-genomic sequence analysis
Modulkürzel	mar622
Credit points	6.0 KP
Workload	180 h (Präsenzzeit: 54 Stunden, Selbststudium: 126 Stunden)
Verwendbarkeit des Moduls	• Master's Programme Marine Environmental Sciences (Master) > Mastermodule • Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	
Prerequisites	Participation in 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 programming languages most used for this purpose is R. After successful participation the students will have the competence to understand, interpret and carry out simple genome sequence analyses. They will acquire transferable skills in using R
Module contents	The course will cover the following topics: 1. programming in R using an integrated development environment (RStudio) 2. working with strings (stringr package) 3. working with lists and data frames (readr and dplyr package) 4. sequence analysis (seqinr, Bioconductor packages: Biostrings, GenomicRanges, Decipher) 5. (meta)-genomic and data visualization (ggplot2, Gviz) 6. Creating sequence / metadata dabases 7. Accessing and mining sequence / metadata databases though R based web applications (Shiny, DT and Shinyjs packages) 8. reporting in R (Rmarkdown and Knitr packages) 9. managing code (Roxygen2 package) 10. microbial genome annotation using R. 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 listed. 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 an analysis report prepared in Rmarkdown and Knitr packages. The report will include both the R code and the genome analysis results.

Literaturempfehlungen	will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	is currently not offered
Module capacity	15 (Proportional allocation between Master MUWI and Master Microbiology.)
Type of module	je nach Studiengang Pflicht oder Wahlpflicht
Teaching/Learning method	Blockveranstaltung: SE/PR: R programming for (meta)-genomic sequence analysis (4 SWS, 6 KP)
Previous knowledge	Participation in mar454 Einführung in die DNA-Sequenzierung und Sequenzanalyse. Basics of programming in R, basics of molecular taxonomy.

Examination	Prüfungszeiten	Type of examination
Final exam of module	Will be announced during the course	Written protocol (80%) and class participation (20%)

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		2	SoSe	28
Practical training		2	SoSe	28
Präsenzzeit Modul insgesamt				56 h

mar630 - Research Project

Module label	Research Project
Modulkürzel	mar630
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (module responsibility) • der Mikrobiologie, Lehrende (Module counselling)
Prerequisites	
Skills to be acquired in this module	The students are able to work (under guidance) on a project dealing with a specific scientific question. They use appropiate methods and carry out experiments to collect data. These data can be documented, analysed and interpreted. The students understand recent scientific literature and can regard it for their own work. They can present and defend their work in the public.
Module contents	The contents concern variable recent scientific questions on a high scientific level.
Literaturempfehlungen	Project-specific, will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	semiannual
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	MM (Mastermodul / Master module)
Teaching/Learning method	Seminar; Practical work
Previous knowledge	1 main module and 1 profile module

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced during the course.	**Two assessments of examination:** Written protocol / 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		6	SoSe oder WiSe	84
Practical training		12	SoSe oder WiSe	168
Präsenzzeit Modul insgesamt				252 h

mar640 - Research Project

Module label	Research Project
Modulkürzel	mar640
Credit points	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (module responsibility) • der Mikrobiologie, Lehrende (Module counselling)
Prerequisites	
Skills to be acquired in this module	The students are able to work (under guidance) on a project dealing with a specific scientific question. They use appropiate methods and carry out experiments to collect data. These data can be documented, analysed and interpreted. The students understand recent scientific literature and can regard it for their own work. They can present and defend their work in the public.
Module contents	The contents concern variable recent scientific questions on a high scientific level.
Literaturempfehlungen	Project-specific, will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	semiannual
Module capacity	unlimited
Type of module	Wahlpflicht / Elective
Module level	MM (Mastermodul / Master module)
Teaching/Learning method	Seminar; Practical work
Previous knowledge	1 main module and 1 profile module

Examination	Prüfungszeiten	Type of examination
Final exam of module	Announced during the course.	**Two assessments of examination:** Written protocol / 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.

Form of instruction	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		6	SoSe oder WiSe	84
Practical training		12	SoSe oder WiSe	168
Präsenzzeit Modul insgesamt				252 h

Abschlussmodul

mam - Master´s Thesis Module

Module label	Master´s Thesis Module
Modulkürzel	mam
Credit points	30.0 KP
Workload	900 h
Verwendbarkeit des Moduls	• Master's Programme Microbiology (Master) > Abschlussmodul
Zuständige Personen	• Könneke, Martin (module responsibility) • der Mikrobiologie, Lehrende (Module counselling) • Haller, Melanie (Prüfungsberechtigt)
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
Literaturempfehlungen	project-specific, will be announced
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	semi-annual
Module capacity	unlimited
Type of module	Pflicht / Mandatory
Module level	Abschlussmodul (Abschlussmodul / Conclude)
Teaching/Learning method	Seminar (2 SPPW); Practical work (28 SPPW)

Examination	Prüfungszeiten	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 %)

Form of instruction	Seminar
SWS	2
Frequency	SoSe und WiSe