Modulhandbuch

Microbiology - Master-Studiengang

im Wintersemester 2020/2021

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Mastermodule

mar500 - Physiology and diversity of microorganisms

Modulbezeichnung	Physiology and diversity of microorganisms
Modulkürzel	mar500
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • der Mikrobiologie, Lehrende (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	**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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Pflicht / Mandatory
Modullevel	BC (Basiscurriculum / Base curriculum)
Lehr-/Lernform	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)

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul		
	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Vorlesung		6	SoSe oder WiSe	84
Übung		2	WiSe	28
Exkursion		1	SoSe oder WiSe	14
Präsenzzeit Modul insgesamt				126 h

mar510 - Molecular Mechanisms and Interactions

Modulbezeichnung	Molecular Mechanisms and Interactions
Modulkürzel	mar510
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Rabus, Ralf Andreas (Modulverantwortung) • der Mikrobiologie, Lehrende (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	**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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Pflicht / Mandatory
Modullevel	BC (Basiscurriculum / Base curriculum)
Lehr-/Lernform	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)

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Vorlesung		4	SoSe	56
Übung		2	SoSe	28
Seminar		2	SoSe oder WiSe	28
Exkursion		1	SoSe oder WiSe	14
Präsenzzeit Modul insgesamt				126 h

mar520 - Main Module Proteomics

Modulbezeichnung	Main Module Proteomics
Modulkürzel	mar520
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Rabus, Ralf Andreas (Modulverantwortung) • Feenders, Christoph (Modulberatung) • Wöhlbrand, Lars (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Hinweise	
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Seminar (2 CP), practical course (10 CP)
Vorkenntnisse	Lecture: Physiology and diversity of prokaryotes, lecture: Molecular Microbiology

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		2	SoSe	28

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Praktikum		8	SoSe	112
Präsenzzeit Modul insgesamt				140 h

mar530 - Main Module Ecophysiology of prokaryotes

Modulbezeichnung	Main Module Ecophysiology of prokaryotes
Modulkürzel	mar530
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • Engelen, Bert (Modulberatung) • der Mikrobiologie, Lehrende (Prüfungsberechtigt)
Teilnahmevoraussetzungen	
Kompetenzziele	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
Modulinhalte	“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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Block course, 4 weeks, seminar and laboratory work
Vorkenntnisse	Lecture: Physiology and diversity of prokaryotes; recommended: Sediment microbiology

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		2	WiSe	28
Übung		8	WiSe	112
Präsenzzeit Modul insgesamt				140 h

mar540 - Main Module Ecology of Marine Microbial communities

Modulbezeichnung	Main Module Ecology of Marine Microbial communities
Modulkürzel	mar540
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Garcia, Sarahi Lorena (Modulverantwortung) • Brinkhoff, Thorsten Henning (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	“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	
Unterrichtsprachen	Englisch, Deutsch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	12
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	seminar + pracitical course/exercise

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1	SoSe	14
Übung		9	SoSe	126
Präsenzzeit Modul insgesamt				140 h

mar550 - Profile Module Physiology of bacteria

Modulbezeichnung	Profile Module Physiology of bacteria
Modulkürzel	mar550
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • Engelen, Bert (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	The students know how to - cultivate bacteria and generate pure cultures - determine growth curves by photometry and counting - prepare and use washed cell suspensions for experiments - measure bacterial activity - use a microscope and take digital microphotographs - quantify and analyze energy metabolism and fundamental physiological processes - present and discuss scientific results - write a scientific protocol
Modulinhalte	The course starts with an introductory seminar every morning. Then, several experiments will be done over two day's round robin. Different physiological processes are analyzed using various techniques, e.g. investigation of microbial growth under oxic and anoxic conditions, determination of protein contents and measurement of substrate turnover rates.
Literaturempfehlungen	will be announced
Links	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)
Vorkenntnisse	Lecture: Physiology and diversity of prokaryotes

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1	WiSe	14
Übung		4	WiSe	56
Präsenzzeit Modul insgesamt				70 h

mar560 - Profile Module Fermentation

Modulbezeichnung	Profile Module Fermentation
Modulkürzel	mar560
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Rabus, Ralf Andreas (Modulverantwortung) • Wöhlbrand, Lars (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	"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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	not offered at the moment
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Seminar (1 SPPW); practical course (4 SPPW)
Vorkenntnisse	Lecture: Physiology and diversity of prokaryotes (successfully completed); Lecture: Molecular Microbiology

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1		14
Praktikum		4		56
Präsenzzeit Modul insgesamt				70 h

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

Modulbezeichnung	Profile Module Introduction to DNA-sequencing and sequence analysis
Modulkürzel	mar570
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Brinkhoff, Thorsten Henning (Modulverantwortung)
Teilnahmevoraussetzungen	
Kompetenzziele	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
Modulinhalte	“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 program ARB will be demonstrated by individual use of laptops of the institute.
Literaturempfehlungen	
Links	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	18
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Seminar; practical course
Vorkenntnisse	Lecture during the course

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		2	SoSe	28
Übung		4	SoSe	56
Präsenzzeit Modul insgesamt				84 h

mar580 - Profile Module Microbial ecology of marine sediments

Modulbezeichnung	Profile Module Microbial ecology of marine sediments
Modulkürzel	mar580
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	“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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	16
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Block course, 2 weeks, seminar and laboratory work
Vorkenntnisse	Lecture: Microbial ecology and Lecture: Sediment microbiology

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Prüfung	Prüfungszeiten	Prüfungsform

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1	SoSe	14
Übung		5	SoSe	70
Präsenzzeit Modul insgesamt				84 h

mar600 - Profile Module Methods in Aquatic Microbial Ecology

Modulbezeichnung	Profile Module Methods in Aquatic Microbial Ecology
Modulkürzel	mar600
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Brinkhoff, Thorsten Henning (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	**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.
Modulinhalte	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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Block course, 2 weeks; practical course and seminar
Vorkenntnisse	For the practical course lecture: Methods in Aquatic Microbial Ecology

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	Will be announced during the course.	**One assessment of examination:** Portfolio: Protocol (100 %), seminar presentation (no mark)

Prüfung	Prüfungszeiten	Prüfungsform
		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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1	WiSe	14
Übung		6	WiSe	84
Präsenzzeit Modul insgesamt				98 h

mar610 - Profile Module Isolation and characterization of microorganisms

Modulbezeichnung	Profile Module Isolation and characterization of microorganisms
Modulkürzel	mar610
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • Engelen, Bert (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	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 analyzed 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
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Seminar and laboratory work, twice per week, half a day each
Vorkenntnisse	Module mar500 including lectures on “Physiology and life modes of prokaryotes” and “Microbial diversity”

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1	SoSe	14
Übung		4	SoSe	56
Präsenzzeit Modul insgesamt				70 h

mar620 - Profile Module Marine Chemical Ecology

Modulbezeichnung	Profile Module Marine Chemical Ecology
Modulkürzel	mar620
Kreditpunkte	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Schupp, Peter (Modulverantwortung) • Kellermann, Matthias (Modulberatung) • Rohde, Sven (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	“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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Compact Course, Seminar, Practical
Vorkenntnisse	Lecture: Organic chemistry

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		1	WiSe	14
Praktikum		4	WiSe	56
Präsenzzeit Modul insgesamt				70 h

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

Modulbezeichnung	Profile Module R programming for (meta)-genomic sequence analysis
Modulkürzel	mar622
Kreditpunkte	6.0 KP
Workload	180 h (Präsenzzeit: 54 Stunden, Selbststudium: 126 Stunden)
Verwendbarkeit des Moduls	• Master Marine Umweltwissenschaften (Master) > Mastermodule • Master Microbiology (Master) > Mastermodule
Zuständige Personen	
Teilnahmevoraussetzungen	Participation in the course „Introduction in sequencing and sequence analysis”. Previous programming experience is not required.
Kompetenzziele	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
Modulinhalte	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	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	is currently not offered
Aufnahmekapazität Modul	15 (Proportional allocation between Master MUWI and Master Microbiology.)
Modulart	Wahlpflicht / Elective
Modullevel	AC (Aufbaucurriculum / Composition)
Lehr-/Lernform	Blockveranstaltung: SE/PR: R programming for (meta)-genomic sequence analysis (4 SWS, 6 KP)
Vorkenntnisse	Participation in mar454 Einführung in die DNA-Sequenzierung und Sequenzanalyse. Basics of programming in R, basics of molecular taxonomy.

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	Will be announced during the course	Written protocol (80%) and class participation (20%)

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		2	SoSe	28
Praktikum		2	SoSe	28
Präsenzzeit Modul insgesamt				56 h

mar630 - Research Project

Modulbezeichnung	Research Project
Modulkürzel	mar630
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • der Mikrobiologie, Lehrende (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	The contents concern variable recent scientific questions on a high scientific level.
Literaturempfehlungen	Project-specific, will be announced
Links	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	semiannual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	MM (Mastermodul / Master module)
Lehr-/Lernform	Seminar; Practical work
Vorkenntnisse	1 main module and 1 profile module

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		6	SoSe oder WiSe	84
Praktikum		12	SoSe oder WiSe	168
Präsenzzeit Modul insgesamt				252 h

mar640 - Research Project

Modulbezeichnung	Research Project
Modulkürzel	mar640
Kreditpunkte	12.0 KP
Workload	360 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Mastermodule
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • der Mikrobiologie, Lehrende (Modulberatung)
Teilnahmevoraussetzungen	
Kompetenzziele	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.
Modulinhalte	The contents concern variable recent scientific questions on a high scientific level.
Literaturempfehlungen	Project-specific, will be announced
Links	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	semiannual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Wahlpflicht / Elective
Modullevel	MM (Mastermodul / Master module)
Lehr-/Lernform	Seminar; Practical work
Vorkenntnisse	1 main module and 1 profile module

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul	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.

Lehrveranstaltungsform	Kommentar	SWS	Angebotsrhythmus	Workload Präsenz
Seminar		6	SoSe oder WiSe	84
Praktikum		12	SoSe oder WiSe	168
Präsenzzeit Modul insgesamt				252 h

Abschlussmodul

mam - Master Thesis Module

Modulbezeichnung	Master Thesis Module
Modulkürzel	mam
Kreditpunkte	30.0 KP
Workload	900 h
Verwendbarkeit des Moduls	• Master Microbiology (Master) > Abschlussmodul
Zuständige Personen	• Könneke, Martin (Modulverantwortung) • der Mikrobiologie, Lehrende (Modulberatung) • Haller, Melanie (Prüfungsberechtigt)
Teilnahmevoraussetzungen	1 research project
Kompetenzziele	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.
Modulinhalte	The contents concern variable recent scientific questions on a high scientific level
Literaturempfehlungen	project-specific, will be announced
Links	
Unterrichtssprache	Englisch
Dauer in Semestern	1 Semester
Angebotsrhythmus Modul	semi-annual
Aufnahmekapazität Modul	unbegrenzt
Modulart	Pflicht / Mandatory
Modullevel	Abschlussmodul (Abschlussmodul / Conclude)
Lehr-/Lernform	Seminar (2 SPPW); Practical work (28 SPPW)

Prüfung	Prüfungszeiten	Prüfungsform
Gesamtmodul		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 %)

Lehrveranstaltungsform	Seminar
SWS	2
Angebotsrhythmus	SoSe und WiSe