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**Modulhandbuch**  
**Microbiology - Master's Programme**  
im Wintersemester 2023/2024  
erstellt am 28/11/23

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## Mastermodule

### mar500 - Physiology and diversity of microorganisms

<b>Module label</b>	Physiology and diversity of microorganisms
<b>Module abbreviation</b>	mar500
<b>Credit points</b>	12.0 KP
<b>Workload</b>	360 h
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könneke, Martin (module responsibility)</li> <li>• der Mikrobiologie, Lehrende (Module counselling)</li> </ul>
<b>Prerequisites</b>	none
<b>Skills to be acquired in this module</b>	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

- Physiology and life modes of prokaryotes (lecture + exercises):

Topics are cellular and subcellular organization, assimilation and dissimulation, energy metabolism, transport, microbial growth, chemiosmotic theory, fermentation, anaerobic respiration, lithotrophy, photosynthesis, metabolism of different Archaea, Bacteria pathogenic prokaryotes, microbiological techniques.

- 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.

- Broadening lectures, one out of the following:

- o 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;

- o 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. P

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

o 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 posters

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

o Alternative lectures of the MSc "Marine environmental sciences" or "Biology" (see current online schedule)

· Excursions into the field, to companies and scientific institutions

· ICBM and microbiological colloquium (alternating weekly)

<b>Recommended reading</b>	Mardigan "Brock - Biology of microorganisms"		
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	2 Semester		
<b>Module frequency</b>	jährlich		
<b>Module capacity</b>	unlimited		
<b>Module level</b>			
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht		
<b>Teaching/Learning method</b>	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)		
<b>Previous knowledge</b>	None		
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	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.	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
			<b>Workload of compulsory attendance</b>
Lecture		6	84
Exercises		2	28
Study trip		1	14
<b>Total module attendance time</b>			126 h

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## mar510 - Molecular Mechanisms and Interactions

<b>Module label</b>	Molecular Mechanisms and Interactions
<b>Module abbreviation</b>	mar510
<b>Credit points</b>	12.0 KP
<b>Workload</b>	360 h
<b>Applicability of the module</b>	<ul style="list-style-type: none"><li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li></ul>
<b>Responsible persons</b>	<ul style="list-style-type: none"><li>• Rabus, Ralf Andreas (module responsibility)</li><li>• der Mikrobiologie, Lehrende (Module counselling)</li></ul>
<b>Prerequisites</b>	none
<b>Skills to be acquired in this module</b>	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. They 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

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### Recommended reading

Molecular Microbiology :

Stryer – Biochemistry

Voet – Biochemistry

Knippers – Molekulare Genetik

Snyder – Molecular Genetics of Bacteria

Brock - Microbiology

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### Links

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<b>Language of instruction</b>	English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	jährlich
<b>Module capacity</b>	unlimited
<b>Module level</b>	
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Teaching/Learning method</b>	Lecture + Exercises: Molecular microbiology, (2 +1 SPPW, 3 CP) Lecture + Exercises: Sediment 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)
<b>Previous knowledge</b>	none

Examination	Examination times	Type of examination
<b>Final exam of module</b>	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.)

Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		4		56
Exercises		2		28
Seminar		2		28
Study trip		1		14
<b>Total module attendance time</b>				<b>126 h</b>

## mar520 - Main Module Proteomics

<b>Module label</b>	Main Module Proteomics		
<b>Module abbreviation</b>	mar520		
<b>Credit points</b>	12.0 KP		
<b>Workload</b>	360 h		
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>		
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Rabus, Ralf Andreas (module responsibility)</li> <li>• Feenders, Christoph (Module counselling)</li> <li>• Wöhlbrand, Lars (Module counselling)</li> </ul>		
<b>Prerequisites</b>	Lecture: Physiology and diversity of prokaryotes Lecture: Molecular Microbiology		
<b>Skills to be acquired in this module</b>	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.		
<b>Module contents</b>	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.		
<b>Recommended reading</b>	Lottspeich - Bioanalytik		
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	1 Semester		
<b>Module frequency</b>	yearly		
<b>Module capacity</b>	unlimited		
<b>Reference text</b>			
<b>Module level</b>			
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht		
<b>Teaching/Learning method</b>	Seminar (2 CP ), practical course (10 CP)		
<b>Previous knowledge</b>	none		
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	Announced at the beginning of the course.		<p>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.</p>
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
			<b>Workload of compulsory attendance</b>
Seminar		2	28
Practical training		8	112
<b>Total module attendance time</b>			140 h

## mar530 - Main Module Ecophysiology of anaerobes

<b>Module label</b>	Main Module Ecophysiology of anaerobes			
<b>Module abbreviation</b>	mar530			
<b>Credit points</b>	12.0 KP			
<b>Workload</b>	360 h			
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>			
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könneke, Martin (module responsibility)</li> <li>• Engelen, Bert (Module counselling)</li> <li>• der Mikrobiologie, Lehrende (Prüfungsberechtigt)</li> </ul>			
<b>Prerequisites</b>				
<b>Skills to be acquired in this module</b>	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.			
<b>Module contents</b>	<p>"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.</p>			
<b>Recommended reading</b>	will be announced			
<b>Links</b>				
<b>Language of instruction</b>	English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	jährlich			
<b>Module capacity</b>	unlimited			
<b>Module level</b>				
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht			
<b>Teaching/Learning method</b>	Block course, 4 weeks, seminar and laboratory work			
<b>Previous knowledge</b>	Lecture: Physiology and diversity of prokaryotes; recommended: Sediment microbiology			
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>		
<b>Final exam of module</b>	Announced during the course.		<p>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.)</p>	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload of compulsory attendance</b>
Seminar		2		28
Exercises		8	--	112
<b>Total module attendance time</b>				<b>140 h</b>



## mar540 - Main Module Ecology of Marine Microbial communities

<b>Module label</b>	Main Module Ecology of Marine Microbial communities	
<b>Module abbreviation</b>	mar540	
<b>Credit points</b>	12.0 KP	
<b>Workload</b>	360 h	
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>	
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Garcia, Sarahi Lorena (module responsibility)</li> <li>• Brinkhoff, Thorsten Henning (Module counselling)</li> </ul>	
<b>Prerequisites</b>	none	
<b>Skills to be acquired in this module</b>	<p>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.</p>	
<b>Module contents</b>	<p>"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.</p>	
<b>Recommended reading</b>	will be announced	
<b>Links</b>		
<b>Languages of instruction</b>	English, German	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>	annuale	
<b>Module capacity</b>	12	
<b>Module level</b>		
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Teaching/Learning method</b>		
<b>Previous knowledge</b>	none	
<b>Examination</b>	Examination times	Type of examination
<b>Final exam of module</b>	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.

Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Exercises		9	--	126
<b>Total module attendance time</b>				<b>140 h</b>

## mar550 - Profile Module Physiology of bacteria

<b>Module label</b>	Profile Module Physiology of bacteria
<b>Module abbreviation</b>	mar550
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könncke, Martin (module responsibility)</li> <li>• Engelen, Bert (Module counselling)</li> </ul>
<b>Prerequisites</b>	
<b>Skills to be acquired in this module</b>	

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

<b>Module contents</b>	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.
<b>Recommended reading</b>	will be announced
<b>Links</b>	
<b>Language of instruction</b>	English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	jährlich
<b>Module capacity</b>	unlimited
<b>Module level</b>	
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Teaching/Learning method</b>	Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)
<b>Previous knowledge</b>	Lecture: Physiology and diversity of prokaryotes

Examination	Examination times	Type of examination
<b>Final exam of module</b>	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.)

Type of course	Comment	SWS	Frequency	Workload of compulsory attendance

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Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Exercises		4	--	56
<b>Total module attendance time</b>				<b>70 h</b>

## mar560 - Profile Module Fermentation

<b>Module label</b>	Profile Module Fermentation			
<b>Module abbreviation</b>	mar560			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>			
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Rabus, Ralf Andreas (module responsibility)</li> <li>• Wöhlbrand, Lars (Module counselling)</li> </ul>			
<b>Prerequisites</b>	Lecture: Physiology and diversity of prokaryotes (successfully completed) Lecture: Molecular Microbiology			
<b>Skills to be acquired in this module</b>	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.			
<b>Module contents</b>	"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. O <sub>2</sub> and pH adjustments and sterile sampling) - determine O <sub>2</sub> -consumption and CO <sub>2</sub> -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			
<b>Recommended reading</b>				
<b>Links</b>				
<b>Language of instruction</b>	English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	jährlich			
<b>Module capacity</b>	unlimited			
<b>Module level</b>				
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht			
<b>Teaching/Learning method</b>	Seminar (1 SPPW); practical course (4 SPPW)			
<b>Previous knowledge</b>	Lecture: Physiology and diversity of prokaryotes (successfully completed); Lecture: Molecular Microbiology			
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>		
<b>Final exam of module</b>	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.)		
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload of compulsory attendance</b>
Seminar		1		14
Practical training		4		56
<b>Total module attendance time</b>				<b>70 h</b>

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

<b>Module label</b>	Profile Module Introduction to DNA-sequencing and sequence analysis		
<b>Module abbreviation</b>	mar570		
<b>Credit points</b>	6.0 KP		
<b>Workload</b>	180 h		
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>		
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Brinkhoff, Thorsten Henning (module responsibility)</li> </ul>		
<b>Prerequisites</b>	Lecture during the course		
<b>Skills to be acquired in this module</b>	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		
<b>Module contents</b>	"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.		
<b>Recommended reading</b>			
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	1 Semester		
<b>Module frequency</b>	annuale		
<b>Module capacity</b>	18		
<b>Module level</b>			
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht		
<b>Teaching/Learning method</b>	Seminar (1 SPPW); practical course (4 SPPW)		
<b>Previous knowledge</b>	Lecture during the course		
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	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.)	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
Seminar		1	
Exercises		4	--
<b>Total module attendance time</b>			70 h

## mar580 - Profile Module Microbial ecology of marine sediments

<b>Module label</b>	Profile Module Microbial ecology of marine sediments		
<b>Module abbreviation</b>	mar580		
<b>Credit points</b>	6.0 KP		
<b>Workload</b>	180 h ( (Präsenzzeit: 70 h, Eigenstudium: 110 Stunden) )		
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>		
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Engelen, Bert (module responsibility)</li> <li>• Könneke, Martin (Module counselling)</li> </ul>		
<b>Prerequisites</b>	Lecture: Microbial ecology and Lecture: Sediment microbiology		
<b>Skills to be acquired in this module</b>	The students know how to take samples from marine habitats and characterize those biogeochemically and microbiologically. Furthermore, students learn to collect and analyze 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.		
<b>Module contents</b>	<p>"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 analyzed 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.</p>		
<b>Recommended reading</b>			
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	1 Semester		
<b>Module frequency</b>	jährlich		
<b>Module capacity</b>	16		
<b>Module level</b>			
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht		
<b>Teaching/Learning method</b>	Block course, 2 weeks, seminar and laboratory work		
<b>Previous knowledge</b>	Lecture: Microbial ecology and Lecture: Sediment microbiology		
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	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.)	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
			<b>Workload of compulsory attendance</b>
Seminar		1	14
Practical training		4	56

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Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
<b>Total module attendance time</b>				70 h

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## mar600 - Profile Module Methods in Aquatic Microbial Ecology

<b>Module label</b>	Profile Module Methods in Aquatic Microbial Ecology
<b>Module abbreviation</b>	mar600
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Applicability of the module</b>	<ul style="list-style-type: none"><li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li></ul>
<b>Responsible persons</b>	<ul style="list-style-type: none"><li>• Brinkhoff, Thorsten Henning (Module counselling)</li></ul>
<b>Prerequisites</b>	For the practical course lecture: Methods in Aquatic Microbial Ecology
<b>Skills to be acquired in this module</b>	

### 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).
- determine bacterial cell numbers by flow cytometry and epifluorescence microscopy and to analyze 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 analyze 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.

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### 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.

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<b>Recommended reading</b>	Lecture notes, available on Stud.IP
<b>Links</b>	
<b>Language of instruction</b>	English

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<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	annuale
<b>Module capacity</b>	unlimited
<b>Module level</b>	
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Teaching/Learning method</b>	Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)
<b>Previous knowledge</b>	For the practical course lecture: Methods in Aquatic Microbial Ecology

Examination	Examination times	Type of examination
<b>Final exam of module</b>	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.)

Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Exercises		4	--	56
<b>Total module attendance time</b>				<b>70 h</b>

## mar610 - Profile Module Isolation and characterization of microorganisms

<b>Module label</b>	Profile Module Isolation and characterization of microorganisms	
<b>Module abbreviation</b>	mar610	
<b>Credit points</b>	6.0 KP	
<b>Workload</b>	180 h	
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>	
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könncke, Martin (module responsibility)</li> <li>• Engelen, Bert (Module counselling)</li> </ul>	
<b>Prerequisites</b>		
<b>Skills to be acquired in this module</b>	<p>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.</p>	
<b>Module contents</b>	<p>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.</p> <p>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.</p>	
<b>Recommended reading</b>	<p>Brock "Biology of Microorganisms", Cypionka "Grundlagen der Mikrobiologie", Drews "Mikrobiologisches Praktikum", DSMZ catalogue (<a href="http://www.dsmz.de">www.dsmz.de</a>), Dyer "A field guide to the bacteria", Reddy "Methods for general and molecular Microbiology", Steinbüchel "Mikrobiologisches Praktikum", <a href="http://www.microbiological-garden.net">www.microbiological-garden.net</a></p>	
<b>Links</b>		
<b>Language of instruction</b>	English	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>	jährlich	
<b>Module capacity</b>	unlimited	
<b>Module level</b>		
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Teaching/Learning method</b>	Seminar and laboratory work, twice per week, half a day each	
<b>Previous knowledge</b>	Module mar500 including lectures on "Physiology and life modes of prokaryotes" and "Microbial diversity"	
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>
<b>Final exam of module</b>	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.)

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Examination		Examination times	Type of examination	
Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
<b>Total module attendance time</b>				<b>70 h</b>

## mar620 - Profile Module Marine Chemical Ecology

<b>Module label</b>	Profile Module Marine Chemical Ecology		
<b>Module abbreviation</b>	mar620		
<b>Credit points</b>	6.0 KP		
<b>Workload</b>	180 h		
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>		
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Schupp, Peter (module responsibility)</li> <li>• Kellermann, Matthias (Module counselling)</li> <li>• Rohde, Sven (Module counselling)</li> </ul>		
<b>Prerequisites</b>	Lecture: Organic chemistry		
<b>Skills to be acquired in this module</b>	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 isolate 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.		
<b>Module contents</b>	<p>"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.</p>		
<b>Recommended reading</b>	Marine Chemical Ecology, McClintock, Baker		
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	1 Semester		
<b>Module frequency</b>	jährlich		
<b>Module capacity</b>	unlimited		
<b>Module level</b>			
<b>Type of module</b>	je nach Studiengang Pflicht oder Wahlpflicht		
<b>Teaching/Learning method</b>	Compact Course, Seminar, Practical		
<b>Previous knowledge</b>	Lecture: Organic chemistry		
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	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.)	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
Seminar		1	14
Practical training		4	56
<b>Total module attendance time</b>			70 h

## mar621 - Profile Module Techniques in light microscopy and electron microscopy

<b>Module label</b>	Profile Module Techniques in light microscopy and electron microscopy			
<b>Module abbreviation</b>	mar621			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>			
<b>Responsible persons</b>				
<b>Prerequisites</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Recommended reading</b>				
<b>Links</b>				
<b>Language of instruction</b>	English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	is currently not offered			
<b>Module capacity</b>	unlimited			
<b>Module level</b>				
<b>Type of module</b>				
<b>Teaching/Learning method</b>				
<b>Previous knowledge</b>				
Examination	Examination times	Type of examination		
<b>Final exam of module</b>				
Type of course	Comment	SWS	Frequency	Workload of compulsory attendance
Seminar		1		14
Practical training		4		56
<b>Total module attendance time</b>				<b>70 h</b>

## mar630 - Research Project

<b>Module label</b>	Research Project		
<b>Module abbreviation</b>	mar630		
<b>Credit points</b>	12.0 KP		
<b>Workload</b>	360 h		
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>		
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könncke, Martin (module responsibility)</li> <li>• der Mikrobiologie, Lehrende (Module counselling)</li> </ul>		
<b>Prerequisites</b>	1 main and 1 profile module		
<b>Skills to be acquired in this module</b>	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.		
<b>Module contents</b>	The contents concern variable recent scientific questions on a high scientific level.		
<b>Recommended reading</b>	project-specific, will be announced		
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	2 Semester		
<b>Module frequency</b>	halbjährlich		
<b>Module capacity</b>	unlimited		
<b>Module level</b>			
<b>Type of module</b>	Pflicht / Mandatory		
<b>Teaching/Learning method</b>	Seminar (2 SPPW); Practical work (4 SPPW)		
<b>Previous knowledge</b>	1 main module and 1 profile module		
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	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.)	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Workload of compulsory attendance</b>
Seminar		6	84
Practical training		12	168
<b>Total module attendance time</b>			252 h

## mar640 - Research Project

<b>Module label</b>	Research Project		
<b>Module abbreviation</b>	mar640		
<b>Credit points</b>	12.0 KP		
<b>Workload</b>	360 h		
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Mastermodule</li> </ul>		
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könncke, Martin (module responsibility)</li> <li>• der Mikrobiologie, Lehrende (Module counselling)</li> </ul>		
<b>Prerequisites</b>	1 main and 1 profile module		
<b>Skills to be acquired in this module</b>	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.		
<b>Module contents</b>	The contents concern variable recent scientific questions on a high scientific level.		
<b>Recommended reading</b>	project-specific, will be announced		
<b>Links</b>			
<b>Language of instruction</b>	English		
<b>Duration (semesters)</b>	2 Semester		
<b>Module frequency</b>	halbjährlich		
<b>Module capacity</b>	unlimited		
<b>Module level</b>			
<b>Type of module</b>	Pflicht / Mandatory		
<b>Teaching/Learning method</b>	Seminar (2 SPPW); Practical work (4 SPPW)		
<b>Previous knowledge</b>			
<b>Examination</b>	<b>Examination times</b>	<b>Type of examination</b>	
<b>Final exam of module</b>	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 %).	
<b>Type of course</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
			<b>Workload of compulsory attendance</b>
Seminar		6	84
Practical training		12	168
<b>Total module attendance time</b>			252 h

# Abschlussmodul

## mam - Master's Thesis Module

<b>Module label</b>	Master's Thesis Module	
<b>Module abbreviation</b>	mam	
<b>Credit points</b>	30.0 KP	
<b>Workload</b>	900 h	
<b>Applicability of the module</b>	<ul style="list-style-type: none"> <li>• Master's Programme Microbiology (Master) &gt; Abschlussmodul</li> </ul>	
<b>Responsible persons</b>	<ul style="list-style-type: none"> <li>• Könneke, Martin (module responsibility)</li> <li>• der Mikrobiologie, Lehrende (Module counselling)</li> <li>• Haller, Melanie (Prüfungsberechtigt)</li> </ul>	
<b>Prerequisites</b>	1 research project	
<b>Skills to be acquired in this module</b>	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.	
<b>Module contents</b>	The contents concern variable recent scientific questions on a high scientific level	
<b>Recommended reading</b>	project-specific, will be announced	
<b>Links</b>		
<b>Language of instruction</b>	English	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>	halbjährlich	
<b>Module capacity</b>	unlimited	
<b>Module level</b>		
<b>Type of module</b>	Pflicht / Mandatory	
<b>Teaching/Learning method</b>	Seminar (2 SPPW); Practical work (28 SPPW)	
<b>Previous knowledge</b>		
Examination	Examination times	Type of examination
<b>Final exam of module</b>		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 %)
<b>Type of course</b>	Seminar	
<b>SWS</b>	2	
<b>Frequency</b>		
<b>Workload Präsenzzeit</b>	28 h	



