Modulhandbuch

Microbiology - Master-Studiengang

im Wintersemester 2021/2022

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Mastermodule
mar500 - Physiology and diversity of microorganisms

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<th>Physiology and diversity of microorganisms</th>
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<tr>
<td>Modulkürzel</td>
<td>mar500</td>
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<tr>
<td>Kreditpunkte</td>
<td>12.0 KP</td>
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<tr>
<td>Workload</td>
<td>360 h</td>
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<tr>
<td>Verwendbarkeit des Moduls</td>
<td>• Master Microbiology (Master) &gt; Mastermodule</td>
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<tr>
<td>Zuständige Personen</td>
<td>Könneke, Martin (Modulverantwortung)</td>
</tr>
<tr>
<td></td>
<td>der Mikrobiologie, Lehrende (Modulberatung)</td>
</tr>
</tbody>
</table>

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

- Physiology and life modes of prokaryotes (lecture + exercises):
  - Topics are cellular and subcellular organization, assimilation and dissimilation, energy metabolism, transport, microbial growth, respiration, 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, fungi, slime molds, phagocytosis, symbioses, pathogenic eukaryotes, diversity of eukaryotic microbes, components of viruses, virus reproduction, bacteriophages, diversity of viruses, virus diseases.
- Broadening lectures, one 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. Further 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 requirements are important for the different parts. Furthermore, students will train to give oral presentations as well as scientific reports and posters as well as 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)
    - Excursions into the field, to companies and scientific institutions
    - ICBM and microbiological colloquium (alternating weekly)

Literaturrempfehlungen

Mardigan “Brock - Biology of microorganisms”
### Unterrichtssprache
Englisch

### Dauer in Semestern
2 Semester

### Angebotsrhythmus Modul
jährlich

### Aufnahmekapazität Modul
unbegrenzt

### Modullevel / module level
je nach Studiengang Pflicht oder Wahlpflicht

### Lehre-/Lernform / Teaching/Learning method
- Lecture + Exercises: Physiology and life modes of prokaryotes (2 + 1 semester periods per week [SPPW], 3 CP)
- Lecture + Exercises: Microbial diversity (2 + 1 SPPW, 3 CP)
- 1x broadening lecture or seminar (Biological significance of suspended matter / Sediment microbiology / Scientific writing and presentation) (2 SPPW, 3 CP)
- Microbiological + ICBM Colloquium (2 CP)
- Excursions (1 CP)

### Vorkenntnisse / Previous knowledge
None

### Prüfung


#### 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.

<table>
<thead>
<tr>
<th>Lehrveranstaltungsform</th>
<th>Kommentar</th>
<th>SWS</th>
<th>Angebotsrhythmus</th>
<th>Workload Präsenz</th>
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**Präsenzzzeit 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
- der Mikrobiologie, Lehrende (Modulberatung)
- Rabus, Ralf Andreas (Modulverantwortung)

Teilnehmervoraussetzungen

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

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 and style of scientific publications, presentation and discussion of own written elaborations
- Excursions into the field

Literaturempfehlungen
- Molecular Microbiology:
  - Stryer – Biochemistry
  - Voet – Biochemistry
- Knippers – Molekulare Genetik
- Snyder – Molecular Genetics of Bacteria
- Brock - Microbiology

Links

Unterrichtssprache | Englisch
Dauer in Semestern | 1 Semester
Angebotsrhythmus Modul | jährlich
Aufnahmekapazität Modul | unbegrenzt
Modullevel / module level | ---
Modulart / typ of module | Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method
- Lecture + Exercises: Molecular microbiology, (2 +1 SPPW, 3 CP)
- Lecture + Exercises: Microbial ecology (2 + 1 SPPW, 3 CP)
- Broadening lecture: Scientific writing and presentation (2 SPPW, 3 CP)
- Excursion (1 CP)
- Microbiological + ICBM Colloquium (2 CP)

Vorkenntnisse / Previous knowledge
none

Prüfung

Prüfungszeiten

Prüfungsform

Gesammodul
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.)

Lehrveranstaltungsform

Kommentar

SWS

Angabebotsrhythmus

Workload Präsenz

Vorlesung
4

5 / 25
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mar520 - Main Module Proteomics

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Verwendbarkeit des Moduls
- Master Microbiology (Master) > Mastermodule

Zuständige Personen
- Rabus, Ralf Andreas (Modulverantwortung)
- Wöhlrbrand, Lars (Modulberatung)
- N., N. (Modulberatung)

Teilnahmevoraussetzungen
Lecture: Physiology and diversity of prokaryotes Lecture: Molecular Microbiology

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, 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.

Literaturempfehlungen
Lottspeich - Bioanalytik

Links

Unterrichtssprache
Englisch

Dauer in Semestern
1 Semester

Angebotsrhythmus Modul
jährlich

Aufnahmekapazität Modul
unbegrenzt

Hinweise
12 CP | SE; PR | 2. FS | Rabus

Modullevel / module level
je nach Studiengang Pflicht oder Wahlpflicht

Lehr-/Lernform / Teaching/Learning method
Seminar (2 CP ), practical course (10 CP)

Vorkenntnisse / Previous knowledge

<table>
<thead>
<tr>
<th>Prüfung</th>
<th>Prüfungszeiten</th>
<th>Prüfungsform</th>
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<td>Gesamtmodul</td>
<td>Announced at the beginning of the course.</td>
<td>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</td>
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</table>

Lehrveranstaltungsform

| Seminar                | 2              | 28   |
| Praktikum              | 8              | 112  |

Präsenzzeit Modul insgesamt
140 h
# mar530 - Main Module Ecophysiology of prokaryotes

## Module Information

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<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Mastermodule</td>
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## Responsible Persons

<table>
<thead>
<tr>
<th>Könnke, Martin (Moduleverantwortung)</th>
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<tbody>
<tr>
<td>Engelen, Bert (Modulberatung)</td>
</tr>
<tr>
<td>der Mikrobiologie, Lehrende (Prüfungsberechtigt)</td>
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</table>

## Eligibility Requirements

The students can contribute to current scientific projects (under guidance). They know modern analytical techniques. They know and understand recent scientific literature. They can write scientific reports, present their results and discuss them in the public.

## Module Contents

"Ecophysiology of prokaryotes": Projects derived from current scientific programs are carried out, typically in groups of two students guided by a senior scientist or PhD student. Typical project deal with:
- Anaerobic processes
- Molecular analysis of microbial communities
- Sediment microbiology
- Physiological experiments and activity measurements
- Impact of viruses
- Microscopic analysis of chemotaxis

In the accompanying seminar, recent scientific studies in international journals are presented by the students. The results are summarized and discussed in a protocol fulfilling scientific level requirements.

## Literature Recommendations

will be announced

## Other Information

<table>
<thead>
<tr>
<th>Unterrichtssprache</th>
<th>Englisch</th>
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<tr>
<td>Dauer in Semestern</td>
<td>1 Semester</td>
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<tr>
<td>Angebotsrhythmus Modul</td>
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<td>Aufnahmekapazität Modul</td>
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<td>Modulart / module level</td>
<td>Wahlpflicht / Elective</td>
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<tr>
<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>Block course, 4 weeks, seminar and laboratory work</td>
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## Exam Information

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.)

## Enrollment Capacity

unbegrenzt

## Module Level

Wahlpflicht / Elective

## Teaching/Learning Method

Block course, 4 weeks, seminar and laboratory work

## Previous Knowledge

Lecture: Physiology and diversity of prokaryotes; recommended: Sediment microbiology

## Assessment

<table>
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<th>Gesammodul</th>
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<td>Prüfung</td>
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<td>Prüfungsf orm</td>
<td>Workload Präsenz</td>
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## Course Details

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<tr>
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| Präsenzzzeit Modul insgesamt | 140 h |

8 / 25
mar540 - Main Module Ecology of Marine Microbial communities

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<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Mastermodule</td>
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<td>Zuständige Personen</td>
<td>Simon, Meinhard (Modulverantwortung)</td>
</tr>
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<td></td>
<td>Brinkhoff, Thorsten Henning (Modulberatung)</td>
</tr>
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</table>

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 jährlich
Aufnahmekapazität Modul unbegrenzt
Modullevel / module level Wahlpflicht / Elective

Vorkenntnisse / Previous knowledge

Lecture: Biological significance of suspended matter

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<td>to be announced during the course.</td>
<td>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.</td>
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Lehrveranstaltungsform

| Seminar | 1 | Angebotsrhythmus | 14 |
|----------------------------------|----------------|------------------|
| Praktikum | 9 | Workload | 126 |
| Präsenzzeit Modul insgesamt | 140 h |
mar550 - Profile Module Physiology of bacteria

<table>
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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 the live count
- prepare and use washed cell suspensions for experiments
- measure bacterial activity (respiration, proton translocation, transport processes) and growth
- use and understand the functioning electrodes (pH, O2) and photometers
- use a microscope and take digital microphotographs
- quantity and analyze energy metabolism and fundamental physiological processes
- understand the action of inhibitors
- present and discuss scientific results
- write a scientific protocol.

Modulinhalte
The course starts with an introductory seminar every morning. One enrichment and isolation experiment will be performed over 10 days. Four physiological experiments are done over two day’s round robin. The following processes are analyzed: Growth under oxic and anoxic conditions, respiration with complex and monomer substrates, respiration-driven proton translocation, transport of ions.

Literaturempfehlungen
will be announced

Links

Unterrichtssprache
Englisch

Dauer in Semestern
1 Semester

Angebotsrhythmus Modul
jährlich

Aufnahmekapazität Modul
unbegrenzt

Modullevel / module level
Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method
Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)

Vorkenntnisse / Previous knowledge
Lecture: Physiology and diversity of prokaryotes

Prüfung

Prüfungszeiten

Prüfungsform

Gesammodul
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.)
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mar560 - Profile Module Fermentation

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Zuständige Personen

Rabus, Ralf Andreas (Modulverantwortung)
Wölbrand, Lars (Modulberatung)

Teilnahmevoraussetzungen
Lecture: Physiology and diversity of prokaryotes (successfully completed); Lecture: Molecular Microbiology

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

Aufnahmekapazität Modul
unbegrenzt

Modullevel / module level
Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method
Seminar (1 SPPW); practical course (4 SPPW)

Vorkenntnisse / Previous knowledge
Lecture: Physiology and diversity of prokaryotes (successfully completed); Lecture: Molecular Microbiology

Prüfung
Prüfungszeiten
Prüfungform

Gesamtmodul
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.)

Lehrveranstaltungsform | Kommentar | SWS | Angebotsrhythmus | Workload Präsenz
----------------------|-----------|-----|-----------------|----------------|
Seminar               |           | 1   |                 | 14             |
Praktikum             |           | 4   |                 | 56             |

Präsenzzzeit Modul insgesamt
70 h
mar570 - Profile Module Introduction to DNA-sequencing and sequence analysis

<table>
<thead>
<tr>
<th>Modulbezeichnung</th>
<th>Profile Module Introduction to DNA-sequencing and sequence analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulkürzel</td>
<td>mar570</td>
</tr>
<tr>
<td>Kreditpunkte</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Mastermodule</td>
</tr>
<tr>
<td>Zuständige Personen</td>
<td>Brinkhoff, Thorsten Henning (Modulverantwortung)</td>
</tr>
<tr>
<td></td>
<td>Moraru, Liliana Cristina (Modulberatung)</td>
</tr>
<tr>
<td>Teilnahmeverausschützungen</td>
<td>Lecture during the course</td>
</tr>
<tr>
<td>Kompetenzziele</td>
<td>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</td>
</tr>
<tr>
<td>Modulinhalte</td>
<td>&quot;Introduction into DNA-sequencing and sequence analysis&quot;: 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.</td>
</tr>
</tbody>
</table>

Literaturempfehlungen

Links

Unterrichtssprache                     Englisch

Dauer in Semestern                    1 Semester

Angebotsrhythmus Modul                jährlich

Aufnahmekapazität Modul              unbegrenzt

Modulart / module level              Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method
Seminar (1 SPPW); practical course (4 SPPW)

Vorkenntnisse / Previous knowledge   Lecture during the course

Prüfung                              Prüfungszeiten

Gesamtmodul                           Announced during the course.

Lehrveranstaltungsform               Prüfungsform
Seminar                              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.)
Praktikum                           Seminar

Prüfung                              SWS
Seminar                              1
Praktikum                            4

Präsenzzeit Modul insgesamt          70 h
mar580 - Profile Module Microbial ecology of marine sediments

<table>
<thead>
<tr>
<th>Modulbezeichnung</th>
<th>Profile Module Microbial ecology of marine sediments</th>
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</thead>
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<tr>
<td>Modulkürzel</td>
<td>mar580</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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</tbody>
</table>

Verwendbarkeit des Moduls
- Master Microbiology (Master) > Mastermodule

Zuständige Personen
- Könneke, Martin (Modulverantwortung)
- Engelen, Bert (Modulberatung)

Teilnahmeverursachungen
- Lecture: Microbial ecology and Lecture: Sediment microbiology

Kompetenzziele
The students know how to:
- sample marine sediments
- characterize the cores sedimentologically and biogeochemically
- collect and analyze porewater
- determine total cell counts
- quantify groups of organisms molecular biologically
- cultivate different physiological groups of bacteria
- present and discuss scientific results
- write a scientific protocol

Modulinhalte
“Microbial ecology of marine sediments”: The physiological diversity of microorganisms and their spatial distribution within marine sediments are demonstrated according to chemical and physical parameters. Different physiological groups are analysed along the sediment column of intertidal sandflat or beach. Sediment sampling is performed at the back barrier area of the island “Spiekeroog” at the beginning of the course. Oxygen penetration, porewater sulfate and methane concentrations are measured down to a depth of approx. 5 meters. As microbiological parameters, total cell numbers are counted and the numbers of archaea and bacteria are calculated after quantitative PCR (qPCR). More specifically, the relative amounts of sulfate reducers and methanogens are also determined by qPCR targeting key-genes for sulfate reduction and methanogenesis. Furthermore, every single group of students will specifically enrich one physiological type of microorganisms from distinctive sediment layers. Microbial growth and activity are monitored over the whole period of the course. Accompanying the course, all participants will give a talk to introduce “their” physiological group concerning its ecology, physiology, and strategies for a specific enrichment. All the data and observations of the single groups will be combined at the end of the course to draw an overall picture of microbial diversity and the occurrence of the different physiological groups corresponding to relevant geochemical gradients.

Literaturempfehlungen

Links
- Englisch

Dauer in Semestern
1 Semester

Angebotsrhythmus Modul
jährlich

Aufnahmekapazität Modul
unbegrenzt

Modulart / module level
je nach Studiengang Pflicht oder Wahlpflicht

L Lehr-/Lernform / Teaching/Learning method
- Block course, 2 weeks, seminar and laboratory work

Vorkenntnisse / Previous knowledge
- Lecture: Microbial ecology and Lecture: Sediment microbiology

Prüfung
- Anounced during the course.

Prüfungsform
- 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.)

Lehrveranstaltungsform
- Seminar
- Praktikum

Kommentar

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<tr>
<th>SWS</th>
<th>Angebotsrhythmus</th>
<th>Workload Präsenz</th>
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<tbody>
<tr>
<td>1</td>
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<td>14</td>
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<tr>
<td>4</td>
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</table>

Präsenzzeit Modul insgesamt
70 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:
- Simon, Meinhard (Modulverantwortung)
- Brinkhoff, Thorsten Henning (Modulberatung)

Teilnahmevoraussetzungen: For the practical course lecture: Methods in Aquatic Microbial Ecology

Kompetenzziele:
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.

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 denaturing gradient gel electrophoresis (DGGE) of 16S rRNA targeted gene fragments.

The main emphasis is on analyses and approaches of bacterial communities in the water column.

Literaturempfehlungen: Lecture notes, available on Stud.IP

Links

Unterrichtssprache: Englisch

Dauer in Semestern: 1 Semester

Angebotsrhythmus Modul: jährlich

Aufnahmekapazität Modul: unbegrenzt

Modullevel / module level: Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method: Block course, 2 weeks; practical course (4 SPPW) and seminar (1 SPPW)

Vorkenntnisse / Previous knowledge: For the practical course lecture: Methods in Aquatic Microbial Ecology
<table>
<thead>
<tr>
<th>Prüfung</th>
<th>Prüfungszeiten</th>
<th>Prüfungsform</th>
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<td>Will be announced during the course.</td>
<td>One assessment of examination: Portfolio (seminar presentation, written protocol)</td>
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<td></td>
<td>Protocol (100 %), seminar presentation (no mark).</td>
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<tr>
<td>Praktikum</td>
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<td>4</td>
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<tr>
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<td></td>
<td></td>
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mar610 - Profile Module Isolation and characterization of microorganisms

Profile Module Isolation and characterization of microorganisms

Profile Module Isolation and characterization of microorganisms

Profile Module Isolation and characterization of microorganisms

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Profile Module Isolation and characterization of microorganisms
## mar620 - Profile Module Marine Chemical Ecology

<table>
<thead>
<tr>
<th>Modulbezeichnung</th>
<th>Profile Module Marine Chemical Ecology</th>
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</thead>
<tbody>
<tr>
<td>Modulkürzel</td>
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<tr>
<td>Kreditpunkte</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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<tr>
<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Mastermodule</td>
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<tr>
<td>Zuständige Personen</td>
<td>Rohde, Sven (Modulberatung)</td>
</tr>
<tr>
<td></td>
<td>Schupp, Peter (Modulverantwortung)</td>
</tr>
</tbody>
</table>

### 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 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.

### 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
Marine Chemical Ecology, McClintock, Baker

### Prüfung
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.)

<table>
<thead>
<tr>
<th>Lehrveranstaltungsform</th>
<th>Kommentar</th>
<th>SWS</th>
<th>Angebotsrhythmus</th>
<th>Workload Präsenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar</td>
<td></td>
<td>1</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Praktikum</td>
<td></td>
<td>4</td>
<td></td>
<td>56</td>
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</tbody>
</table>

Präsenzzeit Modul insgesamt 70 h
mar621 - Profile Module Techniques in light microscopy and electron microscopy

Modulbezeichnung | Profile Module Techniques in light microscopy and electron microscopy
--- | ---
Modulkürzel | mar621
Kreditpunkte | 6.0 KP
Workload | 180 h
Verwendbarkeit des Moduls | Master Microbiology (Master) > Mastermodule

Zuständige Personen
Rhiel, Erhard (Modulverantwortung)

Teilnahmevoraussetzungen
none

Kompetenzziele
The students will learn
- the basics/theory of scanning electron microscopy (SEM) and transmission electron microscopy (TEM)
- different sample preparation methods for SEM
- to operate our scanning electron microscope
- to operate our critical point drying device
- to perform sputter coating
- to perform negative staining TEM
- to operate our transmission electron microscope
- to perform immuno-labelling for light microscopy

Modulinhalte
The profile module "Techniques in light microscopy and electron microscopy" runs over a period of 10 days, distributed over three weeks. On the first day, seminars will introduce into the theory, i.e. of SEM and TEM. The remaining 9 days are for practice. The main topics of the course are: basic principles and functioning of light and electron microscopes, sample preparation, fixation, low temperature SEM, low vacuum SEM, negative staining TEM, and immuno-labelling for light microscopy.

Literaturrempfehlungen
will be announced

Links

Unterrichtssprache | Englisch
Dauer in Semestern | 1 Semester
Angebotsrhythmus Modul | jährlich
Aufnahmekapazität Modul | unbegrenzt
Modullevel / module level | MM (Mastermodul / Master module)
Modulart / typ of module | je nach Studiengang Pflicht oder Wahlpflicht

Lehr-/Lernform / Teaching/Learning method
Seminar and laboratory work, at three days for three weeks

Vorkenntnisse / Previous knowledge

Prüfung | Prüfungszeiten | Prüfungsf orm
--- | --- | ---
Gesamtmodul | after delivery of the two course assessments | One assessments of examination: Portfolio: Written protocol and contribution to the seminar (seminar presentation) One assessment of examination: (seminar presentation, poster). Active participation (Active and documented participation in practical courses (labs, exercises, seminars, field trips) and courses. These include e.g. the delivery of exercises, writing a lab report or seminar presentations according to the advice of the course supervisor.)

| Lehrveranstaltungsform | Kommentar | SWS | Angebotsrhythmus | Workload Präsenz |
--- | --- | --- | --- | ---
Seminar | 1 |  |  | 14 |
Praktikum | 4 |  |  | 56 |
Präsenzzzeit Modul insgesamt |  |  |  | 70 h |
mar630 - Research Project

<table>
<thead>
<tr>
<th>Modulbezeichnung</th>
<th>Research Project</th>
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</thead>
<tbody>
<tr>
<td>Modulkürzel</td>
<td>mar630</td>
</tr>
<tr>
<td>Kreditpunkte</td>
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<tr>
<td>Workload</td>
<td>360 h</td>
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<tr>
<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Mastermodule</td>
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<tr>
<td>Zuständige Personen</td>
<td>Könneke, Martin (Modulverantwortung)</td>
</tr>
<tr>
<td></td>
<td>der Mikrobiologie, Lehrende (Modulberatung)</td>
</tr>
<tr>
<td>Teilnahmevoraussetzungen</td>
<td>1 main module and 1 profile module</td>
</tr>
<tr>
<td>Kompetenzziele</td>
<td>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.</td>
</tr>
<tr>
<td>Modulinhalte</td>
<td>The contents concern variable recent scientific questions on a high scientific level.</td>
</tr>
<tr>
<td>Literaturempfehlungen</td>
<td>project-specific, will be announced</td>
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<tr>
<td>Links</td>
<td>Englisch</td>
</tr>
<tr>
<td>Unterrichtssprache</td>
<td>2 Semester</td>
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<tr>
<td>Angebotsrhythmus Modul</td>
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<tr>
<td>Aufnahmekapazität Modul</td>
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<tr>
<td>Modullevel / module level</td>
<td>MM (Mastermodul / Master module)</td>
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<tr>
<td>Modulart / typ of module</td>
<td>Pflicht / Mandatory</td>
</tr>
<tr>
<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>Seminar (2 SPPW); Practical work (4 SPPW)</td>
</tr>
<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>1 main module and 1 profile module</td>
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<tr>
<td>Prüfung</td>
<td>Announced during the course.</td>
</tr>
<tr>
<td>Prüfungszeiten</td>
<td>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.)</td>
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<tr>
<td>Seminar</td>
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<tr>
<td>Praktikum</td>
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<td>12</td>
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<td>168</td>
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<tr>
<td>Präsennzeit Modul insgesamt</td>
<td></td>
<td></td>
<td></td>
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# mar640 - Research Project

<table>
<thead>
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<th>Modulbezeichnung</th>
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<tbody>
<tr>
<td>Modulkürzel</td>
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<tr>
<td>Kreditpunkte</td>
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<tr>
<td>Workload</td>
<td>360 h</td>
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<tr>
<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Mastermodule</td>
</tr>
</tbody>
</table>

**Zuständige Personen**
- Könneke, Martin (Modulverantwortung)
- der Mikrobiologie, Lehrende (Modulberatung)

**Kompetenzziele**
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.

**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**
2 Semester

**Angebotsrhythmus Modul**
halbjährlich

**Aufnahmekapazität Modul**
unbegrenzt

**Modullevel / module level**
MM (Mastermodul / Master module)

**Modulart / typ of module**
Pflicht / Mandatory

**Lehr-/Lernform / Teaching/Learning method**
Seminar (2 SPPW); Practical work (4 SPPW)

**Vorkenntnisse / Previous knowledge**

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<thead>
<tr>
<th>Prüfung</th>
<th>Prüfungszeiten</th>
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<td>Gesamtmodul</td>
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<tr>
<td>Praktikum</td>
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<td>168</td>
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</table>

**Präsenzzeit Modul insgesamt**
252 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**
- Moraru, Liliana Cristina (Modulverantwortung)

**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 databases
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
<table>
<thead>
<tr>
<th>Angebotsrhythmus Modul</th>
<th>jährlich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aufnahmekapazität Modul</td>
<td>15 (Proportionale Aufteilung zwischen Master MUWI und Master Microbiology)</td>
</tr>
<tr>
<td>Modullevel / module level</td>
<td>AC (Aufbaucurriculum / Composition)</td>
</tr>
<tr>
<td>Modular / typ of module</td>
<td>Wahlpflicht / Elective</td>
</tr>
<tr>
<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>Blockveranstaltung: SE/PR: R programming for (meta)-genomic sequence analysis (4 SWS, 6 KP)</td>
</tr>
<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>Teilnahme an mar454 Einführung in die DNA-Sequenzierung und Sequenzanalyse. Grundlagen der Programmierung in R, Grundlagen der Molekularen Taxonomie</td>
</tr>
</tbody>
</table>

### Prüfung
- **Gesamtmodul:** Will be announced during the course
- **Prüfung:** Written protocol (80%) and class participation (20%)

### Lehrveranstaltungsform

<table>
<thead>
<tr>
<th>Lehrveranstaltungsform</th>
<th>Kommentar</th>
<th>SWS</th>
<th>Angebotsrhythmus</th>
<th>Workload Präsenz</th>
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</thead>
<tbody>
<tr>
<td>Seminar</td>
<td>2</td>
<td>SoSe</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>Praktikum</td>
<td>2</td>
<td>SoSe</td>
<td>28</td>
<td>28</td>
</tr>
</tbody>
</table>

### Präsenzzeit Modul insgesamt
- 56 h
**Abschlussmodul**

*mam - Master Thesis Module*

<table>
<thead>
<tr>
<th>Modulbezeichnung</th>
<th>Master Thesis Module</th>
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<tbody>
<tr>
<td>Modulkürzel</td>
<td>mam</td>
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<tr>
<td>Kreditpunkte</td>
<td>30.0 KP</td>
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<tr>
<td>Workload</td>
<td>900 h</td>
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<td>Verwendbarkeit des Moduls</td>
<td>Master Microbiology (Master) &gt; Abschlussmodul</td>
</tr>
<tr>
<td>Zuständige Personen</td>
<td>Königneke, Martin (Modulverantwortung) der Mikrobiologie, Lehrende (Modulberatung)</td>
</tr>
<tr>
<td>Teilnahmevoraussetzungen</td>
<td>1 research project</td>
</tr>
<tr>
<td>Kompetenzziele</td>
<td>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.</td>
</tr>
<tr>
<td>Modulinhalte</td>
<td>The contents concern variable recent scientific questions on a high scientific level</td>
</tr>
<tr>
<td>Literatureempfehlungen</td>
<td>project-specific, will be announced</td>
</tr>
<tr>
<td>Unterrichtssprache</td>
<td>Englisch</td>
</tr>
<tr>
<td>Dauer in Semestern</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Angebotsrhythmus Modul</td>
<td>halbjährlich</td>
</tr>
<tr>
<td>Aufnahmekapazität Modul</td>
<td>unbegrenzt</td>
</tr>
<tr>
<td>Modullevel / module level</td>
<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
</tr>
<tr>
<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>Seminar (2 SPPW); Practical work (28 SPPW)</td>
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<tr>
<td>Vorkenntnisse / Previous knowledge</td>
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<tr>
<td>Prüfung</td>
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<tr>
<td>Gesamtnote / module level</td>
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<tr>
<td>Lehrveranstaltungsform</td>
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<tr>
<td>SWS</td>
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<tr>
<td>Angebotsrhythmus</td>
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<tr>
<td>Workload Präsenzzeit</td>
<td>28 h</td>
</tr>
</tbody>
</table>

*Links*

*Unterrichtsprache*: Englisch

*Literaturempfehlungen*: project-specific, will be announced

*Unterrichtsprache*: Englisch

*Dauer in Semestern*: 1 Semester

*Angebotsrhythmus Modul*: halbjährlich

*Aufnahmekapazität Modul*: unbegrenzt

*Modullevel / module level*: je nach Studiengang Pflicht oder Wahlpflicht

*Lehr-/Lernform / Teaching/Learning method*: Seminar (2 SPPW); Practical work (28 SPPW)

*Vorkenntnisse / Previous knowledge*:                         

*Prüfung*:                         

*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*:                         

*Workload Präsenzzeit*: 28 h