Module Book

MSc in Molecular Biotechnology

This module description is for all students who have enrolled in the Master‘s program in Molecular Biotechnology with the degree „Master of Science (MSc)“ starting from the winter semester 2023/2024.

(As of April 2024)

Content

Advanced Modules *(Aufbaumodule)*

Module title	Main topics in molecular biotechnology *Zentrale Themen der molekularen Biotechnologie*
Credit points (LP)	12 (360 h)
Degree of commitment	Compulsory module □
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** As part of the exercise, students will receive a comprehensive overview of the structure, synthesis, and modification of biological macromolecules (DNA, RNA, proteins, lipids) and biotechnologically relevant cellular systems. Students will learn the necessary analytical techniques to identify and quantify various cellular components and molecules. This includes the following subject areas: □ Techniques for the purification, sequencing, synthesis, assembly, and modification of nucleic acids □ Recombinant DNA techniques: cloning systems, in vivo recombination, CRISPR applications, strategies of transposon mutagenesis, recoding □ Biochemical analysis of proteins (protein purification, protein quantification, enzyme activity assays, immunological techniques, chemical modification, mass spectrometry, electrophoretic methods, 3D structure elucidation) □ Engineering of proteins and metabolic pathways □ Visualization and analysis of cells and cellular components using light microscopy and flow cytometry The acquired knowledge is also applied to practice critical analysis and discussion of research projects on biotechnologically relevant topics using examples from the original literature. In addition to the exercises, students participate in microbiology seminars where current research topics in microbiology and synthetic biology are presented. Alongside the exercises and seminars, students participate in mentoring sessions with the professors who design the module, in small groups. These meetings provide a framework for regular exchange to support students in choosing workshops from

	thematically related “Technologies and Methods” modules. Additionally, career aspirations can be discussed with students, and guidance on selecting professional internships can be provided. **Qualification goals** After completing the module, students will have comprehensive theoretical knowledge of technologies for the purification, synthesis, analysis and modification of biological metabolites, macromolecules, metabolic pathways and the genetic manipulation of cells. Furthermore, they are able to conduct independent literature searches and to give a presentation on scientific publications in English. This prepares them for active participation in meetings. □
Teaching and learning methods, types of events, semester load	**Exercise**: “Main topics in molecular biotechnology” (4 weekly hours) **Seminar**: “Main topics in molecular biotechnology” (1 weekly hour) **Mentoring**: (1 weekly hour)
Workload	**Exercise**: 64 hours **Seminar**: 16 hours **Mentoring**: 10 hours Self-study, including preparation and taking exams: 270 hours
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master’s program in Molecular Biotechnology
Credit points (LP) requirements	**Study performance:** Active participation in discussions during exercises and seminars **Module exam:** Written exam “Main topics in Molecular Biotechnology” covering the lecture content (12 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master’s Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 Semester
Frequency of the module	Each 2nd semester
Start of the module	Winter semester
Module coordinator (V); lecturer	Becker (V) and group leaders and core facility managers of the Center for Synthetic Microbiology and the Max Planck Institute for Terrestrial Microbiology.

Module title	Biotechnological production *Biotechnologische Produktion*
Credit points (LP)	12 (360 h)
Degree of commitment	Compulsory elective
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** During **exercises** this module introduces participants to different phases of industrial research and development of biotechnological drugs through lectures using specific examples. It covers: • Preclinical research • Pharmacology and toxicology • Biotechnological process development • Formulation and medical devices • Project management • Clinical development • Regulatory affairs • Market development and commercialization The module also introduces participants to roles in the regulated environment of the pharmaceutical and biotechnology industries, emphasizing a problem-based learning approach focusing on practical examples, to demonstrate and explain regulatory requirements, quality management system components including Good Manufacturing Practice, Good Scientific Practice, Good Laboratory Practice and Good Clinical Practice and Quality-by-Design (QbD). The exercise series further provides an in-depth exploration of industrial biotechnology, a field where microorganisms and enzymes are employed for the production of diverse chemical compounds, ranging from fine to bulk chemicals. Different to conventional chemical synthesis methods, industrial biotechnology frequently relies on renewable resources, thereby establishing itself as a more environmentally sustainable approach of manufacturing. Moreover, many biotechnological products exhibit biodegradability, further showing their ecological advantages. These aspects of biotechnological production will be contrasted to the “classical” way of producing chemicals. These insights into the ecological and economic implications of sustainability in biotechnological production will provide an understanding of circular economy principles, and strategies for leveraging renewable resources.

	The series will also explore application of metabolic engineering techniques to improve microbial production strains and advancements in enzyme engineering. It will also cover integrating omics technologies, fermentation protocols, downstream processing methods, and challenges associated with scaling up production facilities. Throughout the module, students engage in self-study by researching original literature on a biotechnologically relevant topic and presenting their findings to peers in **seminars**. Additionally, the module includes a **site visit** to biotechnological production company. **Qualification goals** After successfully completing this module, students will have a detailed overview of the quality and qualification requirements for biotechnological drugs, the associated diverse scientific, technological, and regulatory requirements for research and development work. In particular, an understanding of the differences, contents and requirements that exist in the biotechnological industry – extending beyond the academic, scientific and basic knowledge taught at the university – should be given to the students here. This enables students to relate the relevance of academic education (here biotechnology) to scientific development and documentation in industrial research and development. Students are also empowered to recognize the complex relationships and high demands on science, technology, education, and product and process quality for the successful development and approval of biotechnological drugs. Finally, the important networking of primary biotechnological activities with other essential fields of work and requirements within biotechnological product chains and the resulting individual communicative, interpersonal and intercultural competencies are taught. After completing the module, students will have basic knowledge of manufacturing and quality assurance requirements in the pharmaceutical industry. This module also enables the participants to find their way through the acquired knowledge in the later environment of a pharmaceutical company and to classify and connect the processes within the company. The course provides students with a broad overview of various aspects of industrial biotechnology. In addition to classic applications, they also know the latest biotechnological

	approaches. In particular, the students will have learned about the path from idea to product using selected examples. The module introduces the important topics of the use of renewable raw materials, the circular economy, and the contribution of biotechnology to avoiding greenhouse gases. In addition, the module provides an impression of the diverse tasks and corresponding job profiles in the field of industrial biotechnology. □
Teaching and learning methods, types of events, semester load	**Exercise:** "Fundamentals of Research, Development, Approval, Manufacturing Practices, and Quality Management of Biotechnological Production" (3 weekly hours) **Seminar:** Literature review or homework on a biotechnologically relevant topic and presentation of the work in a seminar session before an audience comprising university professors and industry professionals. **Excursions:** Visits to industrial sites of participating instructors.
Workload	**Exercise**: 36 hours **Seminar,** including preparatory work: 120 hours **Excursion**: three days (3x8 hours) Self-study, including preparation and taking exams: 180 hours
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Partial module examinations** Presentation or poster or written analysis (6 LP) Written exam (6 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 Semester
Frequency of the module	Each 2nd semester
Start of the module	Summer semester
Module coordinator (V); lecturer	Becker (V) and specialist and experienced scientific staff from the relevant departments of industrial research, development, production, and marketing

Module title	Technologies and methods: bio and chemical analytics *Techniken und Methoden: Biologische und chemische Analytik*

Credit points (LP)	6 (180 h)
Degree of commitment	Compulsory module
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** Qualitatively and quantitatively capturing and describing biological systems is an essential prerequisite at every stage of the biotechnological production process, including monitoring product quality and production. The successful implementation of projects in molecular biotechnology thus necessitates a robust understanding of methods. This module aims to impart fundamental methodologies in biochemical and cellular analytics for the quantitative characterization of biological molecules and systems across various thematic domains: A. DNA and RNA technologies encompassing isolation, synthesis, modification, and sequencing of nucleic acids and nucleotides. B. Protein technologies encompassing protein production and purification, interaction analyses (such as hydrogen-deuterium exchange mass spectrometry (HDX), surface plasmon resonance (SPR), bio-layer interferometry (BLI), microscale thermophoresis (MST)), structural biology analyses (such as protein crystallography, cryo-electron microscopy), and yeast-two-hybrid assays. C. Metabolite analysis technologies encompassing chromatography and mass spectrometry. For each thematic area, participants can choose from a selection of method blocks and combine them modularly. In each method block, the theoretical foundations of the respective methods are taught (**exercise**) and then practically applied (**course**). Training takes place in research laboratories with modern equipment. In the **seminar**, participants present and discuss current methodological developments in the field of Synthetic Microbiology and/or the methodology applied within their course program based on publications in international specialist journals. **Qualification goals** After completing the module, students will have basic theoretical and practical knowledge of a self-chosen range of methods in biological and chemical analysis. Building on the previous individual training, the participants have expanded their range of methods precisely to fit their needs. They can use the acquired methodological knowledge to plan and prepare practical experiments and apply them with expertise. They are able to analyze, critically evaluate and document the results of the tests they have obtained. They can work on

	scientific facts from the field of key methods of biological and chemical analysis, communicate them to a specialist audience in the context of a presentation and discuss them. They can understand and use current English-language literature on methodological approaches in biological and chemical analysis.
Teaching and learning methods, types of events, semester load	**Seminar/Poster session:** „New developments in bio and chemical analytics“ (1 weekly hour) **Exercise and Lab-course:** 2 method blocks from the above-mentioned thematic areas. Each thematic block consists of a practical exercise and a course. (For each method block, 3-5 full days)
Workload	Seminar: 10 h 2 x (**Exercise + Lab course**): 2 x 40 h = 80 h Self-study including preparation and taking exams: 90 h
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Presentation in the seminar/poster session and active participation in the discussion of the presentations. **Modul exam** Test report in method block 1 (3 LP) + Test report in method block 2 (3 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master’s Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 Semester
Frequency of the module	Each 2nd semester
Start of the module	Winter semester
Module coordinator; (V), lecturer	Hoffmann (V) and scientific staff from the departments of Biology and Chemistry and the Max Planck Institute for Terrestrial Microbiology.

Module title	Technologies and methods: cell engineering and analytics *Techniken und Methoden: Zell-Engineering und Analytik*
Credit points (LP)	6 (180 h)

Degree of commitment	Mandatory module
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** Qualitatively and quantitatively capturing and describing biological systems is an essential prerequisite at every stage of the biotechnological production process, including monitoring product quality and production. The successful implementation of projects in molecular biotechnology thus necessitates a robust understanding of methods. The module imparts key methods for the genetic manipulation of cells and imaging and non-imaging techniques for the quantitative assessment of cells and cell components, as well as cell cultivation for population and single-cell analytics in the following thematic areas: A. DNA and RNA Technologies Including molecular cloning, DNA assembly, genome editing, recoding, CRISPR systems, transposon mutagenesis B. Imaging, cellular, and cell-free Technologies Including fluorescence microscopy, electron microscopy, Fluorescence-Activated Cell Scanning/Sorting (FACS), microbial cultivation (e.g., high-throughput, bioreactor, microfluidic systems), cell-free reaction systems For each thematic area, participants can choose from a selection of method blocks/workshops and combine them modularly. In each method block, the theoretical foundations of the respective methods are taught (exercise) and then practically applied (course). Training takes place in research laboratories with modern equipment. In the seminar, participants present and discuss current methodological developments in the field of Synthetic Microbiology and/or the methodology applied within their course program based on publications in international specialist journals. **Qualification Goals** After completing the module, students will have basic theoretical and practical knowledge of a self-chosen range of methods for manipulating a wide range of cell-based systems. Building on the previous individual training, the participants have expanded their range of methods precisely to fit their needs. They can use the acquired methodological knowledge to plan and prepare practical experiments and apply them with expertise. They are able to analyze, critically evaluate and document the results of the tests they have obtained. They are able to review scientific facts from the field of key

	methods of manipulating cell functions, communicate them to a specialist audience in the context of a presentation and discuss them. They can understand and use current English-language literature from the fields of genetic engineering of cells and synthetic biology.
Teaching and learning methods, types of events, semester load	**Seminar/Poster session:** „New developments in bio and chemical analytics“ (1 weekly hour) **Exercise and Lab-course:** 2 method blocks from the above-mentioned thematic areas. Each thematic block consists of a practical exercise and a course. (For each method block, 3-5 full days)
Workload	**Seminar**: 10 h 2 x (**Exercise + Lab course**): 2 x 40 h = 80 h Self-study including preparation and taking exams: 90 h
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Presentation in the seminar/poster session and active participation in the discussion of the presentations. **Modul exam** Test report in method block 1 (3 LP) + Test report in method block 2 (3 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master’s Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 Semester
Frequency of the module	Each 2nd semester
Start of the module	Winter semester
Module coordinator; (V), lecturer	Hoffmann (V) and scientific staff from the departments of Biology and Chemistry and the Max Planck Institute for Terrestrial Microbiology.

Module title	Technologies and methods: computational biology *Techniken und Methoden: Bioinformatik*
Credit points (LP)	6 (180 h)

Degree of commitment	Mandatory module
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** Quantitatively capturing and describing biological systems is a fundamental prerequisite for modifying them effectively to suit the needs of biotechnological production processes. The module imparts key methods of bioinformatics for the analysis of biological sequences and "big data" datasets in the following thematic areas: A. Analysis of biological sequences B. Visualization of biological data C. Deep Learning in Medical Informatics For each thematic area, participants can choose from a selection of method blocks and combine them modularly. In each method block, the theoretical foundations of the respective methods are taught (exercise) and then practically applied (course). Training takes place in research laboratories with modern equipment. In the seminar, participants present and discuss current methodological developments in the field of Synthetic Microbiology and/or the methodology applied within their course program based on publications in international specialist journals. **Qualification goals** After completing the module, students will have basic theoretical and practical knowledge of a self-chosen range of methods for the mathematical and bioinformatic analysis of biological systems and sequences. Building on the previous individual training, the participants have expanded their range of methods precisely to fit their needs. They can use the acquired methodological knowledge to plan and prepare practical experiments and apply them with expertise. They are able to analyze, critically evaluate and document the results of the tests they have obtained. They are able to review scientific facts from the field of key methods of manipulating cell functions, communicate them to a specialist audience in the context of a presentation and discuss them. They can understand and use current English-language specialist literature from the fields of biomathematics and bioinformatics.
Teaching and learning methods, types of events, semester load	**Seminar/Poster session:** „New developments in bio and chemical analytics“ (1 weekly hour)

	Exercise and Lab-course: 2 method blocks from the above-mentioned thematic areas. Each thematic block consists of a practical exercise and a course. (For each method block, 3-5 full days)
Workload	**Seminar**: 10 h 2 x (**Exercise + Lab course**): 2 x 40 h = 80 h Self-study including preparation and taking exams: 90 h
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Presentation in the seminar/poster session and active participation in the discussion of the presentations. **Modul exam** Test report in method block 1 (3 LP) + Test report in method block 2 (3 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 Semester
Frequency of the module	Each 2nd semester
Start of the module	Winter semester
Module coordinator; (V), lecturer	Lechner (V) and scientific staff from the departments of Biology and Chemistry and the Max Planck Institute for Terrestrial Microbiology.

Module title	Enzyme production and strain development in bioprocess engineering *Enzymproduktion und Stammentwicklung in der Bioverfahrenstechnik*
Credit points (LP)	6 (180 h)
Degree of commitment	Compulsory elective□
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** Strains utilized for the biotechnological production of biomolecules must be optimized for the respective cultivation conditions and production processes to economically manufacture the desired

	products (e.g., enzymes or fine chemicals) on a large scale. In this lecture, students learn about various strategies and methods for product and strain optimization through high-throughput techniques (e.g., construction and selection of DNA-based libraries; robot-based laboratory automation; lab-on-the-chip, droplet, or single-cell-based assays), as well as the selection and monitoring of production strains and processes. Knowledge is imparted on the design and application of rational engineering methods, as well as directed and experimental evolution in strain development and optimization of product properties (e.g., engineering biochemical properties such as temperature dependence or substrate specificity of enzymes; construction, targeted control, or optimization of biosynthetic metabolic pathways and metabolic fluxes). In the accompanying seminar, students work on new procedures for strain and product optimization from current literature, learn to critically evaluate them, and present the results of their research to a specialized audience in a presentation. During the internship, students independently conduct a project on the experimental evolution of strains and proteins. They learn methods to induce, identify, and characterize the respective evolutionary processes during strain and product optimization. **Qualification goals** The successful completion of the module will enable students to use modern high-throughput- based methods to identify and quantitatively describe constraints in the efficiency of production strains and to develop and implement strategies for improving production capacities. The students will have mastered methods of experimental evolution and can successfully implement them to optimize the metabolic and physiological properties of production strains for fermentation processes and the biochemical properties of the produced proteins.
Teaching and learning methods, types of events, semester load	**Lecture**: "Enzyme Production and Strain Development in Bioprocess Engineering" (2 weekly hours) **Seminar**: "New Strategies in Production Strain Optimization" (2 weekly hours) **Lab course**: "Experimental Evolution" (semester-long lab course, 16 days, half-days)
Workload	Exercises: 20 hours Seminar: 20 hours Lab course: 64 hours

	Self-study: 76 hours
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Presentation in the seminar and protocol for the lab course. **Modul exam** Written exam (6 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 semester
Frequency of the module	Each 2nd semester
Start of the module	Summer semester
Module coordinator (V); lecturer	Erb (V), Bange (V) and scientific staff from the departments of Biology and Chemistry and the Max Planck Institute for Terrestrial Microbiology.

Module title	Bioprocess engineering *Bioverfahrenstechnik*
Credit points (LP)	6 (180 h)
Degree of commitment	Compulsory elective
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** *Biology and Diseases of the Lung- Models and Mechanisms of Therapeutic Approaches and Biomarkers* The **exercise** focuses on the application of 3D models of human organs with an emphasis on lung models. This includes a comparative analysis of different models such as organoids and precision lung slices and their advantages and disadvantages. The production, cultivation and fields of application of various lung models are described and explained. The basics of quality control are taught. Various biotechnological methods for optimizing 3D cultures including bioreactors are described and discussed. The use of these models is presented using specific application examples. The focus will be on chronic and acute lung diseases and the extent to which

	further development of these 3D models can replace mouse models will be discussed. In addition to the lecture, a **seminar** is offered in which students search the original literature for current developments and progress in the development of 3D models 16ft he lung and present their results in a presentation (oral) and discuss them in the group. Students apply the theoretical knowledge acquired in the lecture and seminar in a lab course. In this lab course, students generate 3D models 16ft he lung and examine them using microscopy and molecular biology techniques. **Qualification goals** In this module, students learn basic theories and concepts of human organotypic models. After completing the module, students will have a good knowledge 16of the methods for the qualitative investigation of 3D models 16ft he lung. They have basic knowledge of various organotypic models, their advantages and disadvantages and are able to apply this knowledge and develop strategies for the use of organotypic models and their biotechnological optimization.
Teaching and learning methods, types of events, semester load	**Ecercise** „3D models of human organs“ (2 weekly hours) **Seminar** „New developments 3D modelling of the lung“ (3 weekly hours) **Internship** „3D lung models“ (4 days, full days)
Workload	Exercise: 20 h Seminar: 40 h Lab course: 40h Self-study including writing 16of the internship report: 80h Total: 180 h
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master’s program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Presentation in the seminar and lab course report **Module exam** Written exam (6 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master’s Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 semester

Frequency of the module	Each 2nd semester
Start of the module	Winter semester
Module coordinator (V); lecturer	Lehmann (V)

Module title	Management and Business *Management und Business*
Credit points (LP)	6 (180 h)
Degree of commitment	Compulsory module
Level of proficiency	**Advanced**
Contents and qualification objectives	**Content** This module focuses on providing students with essential knowledge and skills for entrepreneurship and business establishment. Through a combination of online learning materials and in-person sessions, students will explore fundamental concepts in business development, legal considerations, financial management, and marketing strategies. Additionally, the module will cover crucial soft skills such as ideation, pitching techniques, and developing the personal attributes necessary for successful entrepreneurship. In the online component, students will engage with interactive lessons covering topics such as business model creation, designing effective business plans, selecting appropriate legal structures, understanding financing options, navigating tax regulations, and safeguarding intellectual property rights. Furthermore, they will have the opportunity to explore marketing strategies tailored to startup ventures. During the in-person sessions, which complement the online learning, students will participate in discussions to deepen their understanding of the material and apply it to real-world scenarios. Through case studies and guest lectures from experienced entrepreneurs and industry professionals, students will gain practical insights into the challenges and opportunities of launching and managing a successful business. **Qualification goals** Students learn basic theories, concepts and the processes for founding their own company. Since many start-ups fail not because of specialist knowledge but because of personal difficulties, focal "soft skills" for personality training and training of creativity are also included in this offering. This thus puts real applied relevance in

	focus. This is ensured by in-depth exercises and the involvement of practitioners with experience in founding them.
Teaching and learning methods, types of events, semester load	Online lessons 50% Seminar block event 30% Group work 20%
Workload	Exercises: 40 hours Seminar (Block event): 40 hours Group work: 40 hours Self-study: 60 hours
Language of instruction and examination	English
Requirements for participation	None
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Work on exercises accompanying the online lessons **Modul exam** Presentation of a group task as a lecture (indicating individual contribution of every group member) (6 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 Semester
Frequency of the module	Each 2nd semester
Start of the module	Summer semester
Module coordinator (V); lecturer	Bendix (V) and experienced scientific staff from the MAFEX team.

Practical Moduls *(Praxismodul)*

Module title	Internship *Berufsorientierendes-Praktikum*
Credit points (LP)	18 (540 h)
Degree of commitment	Compulsory module
Level of proficiency	**Practice**
Contents and qualification objectives	**Content** Twelve-week, self-organized internship at a potential domestic or foreign workplace for biotechnologists in academic and non-academic settings, such as university laboratories, research and production areas of the biotechnological industry, and clinics with research tasks. **Qualification goals** The students have practiced the steps for a job application. In the internship, which should relate to the molecular cell biological study contents, they have gained an insight into a potential professional field, ideally with the opportunity to apply and test acquired competencies within the scope of their first professional degree. If necessary, they have expanded their specialist knowledge or acquired relevant specialist knowledge in the internship, and/or have developed or learned special techniques with reference to the study contents. They have knowledge of work processes and techniques that do not occur within the scope of the modules of the study program but can complement the degree program in a meaningful way and/or prepare for the step into the profession. They are able to adequately document their experiences in a report. The students have developed perspectives for further studies and/or subsequent professional activities.
Teaching and learning methods, types of events, semester load	**Internship**: Full-time for at least 12 weeks **Seminar**: 1 weekly hour
Workload	In-person on site training and self-study: 540 hours
Language of instruction and examination	English
Requirements for participation	Prior to the start of the internship, the consent of a self-chosen supervisor must be obtained at the Department of Biology who will evaluate the internship report. At least 2 of the 3 modules ☐ Technologies and methods: Bio and Chemical Analytics ☐ Technologies and methods: Cell Engineering and Analytics ☐ Technologies and methods: computational biology

	must have been completed. The main topics in molecular biotechnology module must have been passed.
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Module exam** Internship report or project application (12 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	Full-time for at least 12 weeks
Frequency of the module	Each semester
Start of the module	Summer or Winter semester
Module coordinator (V); lecturer	The chosen supervisor from the Department of Biology

Specialization *(Vertiefungsmodul)*

Module title	Research project *Forschungspraktikum*
Credit points (LP)	12 (360 h)
Degree of commitment	Compulsory module
Level of proficiency	**Specialized**
Contents and qualification objectives	**Content** Experimental work on a clearly defined scientific question from the research spectrum of the working groups involved in the degree program; searching and understanding of the underlying literature; learning the theory and handling of working techniques to be applied. **Qualification goals** After completing the module, students will have specialized theoretical and practical analytical and molecular biology knowledge in the research area of the selected working group and can combine this with the knowledge they have already acquired. They are able to recognize and present complex microbiological relationships. They can apply microbiological, biochemical and molecular biological techniques with expertise in various experimental contexts and plan test series in a guided manner. They are also able to quantitatively evaluate the results of the tests obtained and to critically consider them. They are able to review scientific facts from the fields of microbiology, biochemistry and molecular biology, present them to a specialist audience and discuss them in a lecture. They can understand, critically evaluate and use current English literature from the fields of microbiology, biochemistry and molecular biology.
Teaching and learning methods, types of events, semester load	Supervised laboratory internship with weekly lab seminars (8 weeks)
Workload	Lab course with seminar (Presence, preparation and post-processing including examination): 180 hours
Language of instruction and examination	English
Requirements for participation	At least 36 credits must have been successfully completed in the Advanced area of study, which must be allocated as follows: At least 2 of the 3 modules ☐ Technologies and methods: Bio and Chemical Analytics

	□ Technologies and methods: Cell Engineering and Analytics □ Technologies and methods: computational biology must have been completed. At least 6 credits must have been completed in the compulsory set of electives in Process Engineering in Biotechnology. The main topics in molecular biotechnology module must have been passed. The Management and Business module must have been passed.
Applicability of the module	Master's program in Molecular Biotechnology
Credit points (LP) requirements	**Coursework** Laboratory log **Partial module examinations** Presentation (6 LP) Project report (6 LP)
Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	8 weaks, full days
Frequency of the module	Each semester possible (by arrangement)
Start of the module	Winter or Summer semester
Module coordinator; lecturer	The group leader in whose working group the specialization module is completed is responsible.

Graduation *(Abschlussmodul)*

Module title	Master´s thesis *Masterarbeit*
Credit points (LP)	30
Degree of commitment	Compulsory module
Level of proficiency	**Degree**
Contents and qualification objectives	**Content** Experimental work on a scientific question from the research spectrum of the working groups involved in the degree program; overview of the underlying literature and working techniques to be applied. Independent presentation and critical discussion of the results obtained in a comprehensive written paper. **Qualification goal** The students have substantially improved their theoretical, methodological and practical knowledge in a specialist field of molecular and cellular biology to the latest state of knowledge. They are able to work on a defined topic in a specified time and to face a critical scientific discussion using scientific findings and methods.
Teaching and learning methods, types of events, semester load	Lab internship with weekly lab seminar (whole semester)
Workload	Lab course with seminar (Presence, preparation and post-processing including examination) and writing the final thesis: (900 hours)
Language of instruction and examination	English
Requirements for participation	*Binding condition* Modules of the degree program with at least 72 credit must have been completed. If not all advanced modules have been completed, a consultation with the Office of the Dean Studies is mandatory before starting the master's thesis. *Recommended Prerequisite* The master's thesis should be prepared in the subject area in which the specialization module was also completed.
Applicability of the module	Master’s program in Molecular Biotechnology
Credit points (LP) requirements	Master´s thesis

Grades	Grading of the overall module according to § 28 of the General Regulations for Examination Regulations in Master's Programs at Philipps University Marburg dated September 13, 2010.
Duration of the module	1 semester
Frequency of the module	Each semester possible (by arrangement)
Start of the module	Winter or Summer semester
Module coordinator; lecturer	The group leader in whose working group the specialization module is completed is responsible.