Examination and Study Regulations for the Master's Degree Course 'Infection Biology and Immunology' at the University of Greifswald

Of 16 December 2021

Based on § 2(1) in conjunction with § 38 (1) and § 39 (1) of the Landeshochschulgesetz - LHG M-V (State Higher Education Act), in the version announced on 25 January 2011 (Law and Ordinance Gazette of Mecklenburg-Vorpommern (GVOBl. M-V p. 18)), last amended by the act of 21 June 2021 (GVOBl. M-V p. 1018), the University of Greifswald hereby passes the following Examination and Study Regulations for the international master's degree course 'Infection Biology and Immunology':

Table of Contents

List of Abbreviations

AM	Advanced module
C	Coursework
CA	Confirmation of attendance
CE	Coursework essay
CM	Core module
D	Duration of the module in semesters
ECTS	Credits according to the European Credit Transfer System
EX	Exercises
ID	Identification number
L	Lecture
M	Minutes
MD	Master's dissertation
OE	Oral examination
PL	Practical lab course
PP	Poster presentation
Pr	Presentation
R	Report
RED	Regular examination date (semester)
RP	Research practical
S	Seminar
SA	Scope of assessment
SuSe	Summer semester
SWS	Contact hours per week
TE	Type of examination
WE	Written examination
WiSe	Winter semester
WL	Required workload in hours
WP	Work Placement
-	until
*	unmarked examination/coursework
/	or

§ 1
Scope of Application

These Examination and Study Regulations govern the course content, course organisation and examination procedure in the master's degree course in 'Infection Biology and Immunology' at the University of Greifswald. The General Examination Regulations of the University of Greifswald (*Rahmenprüfungsordnung* – hereinafter RPO) of 18 March 2021 (made public and accessible to all members of the University on 15 April 2021), as amended from time to time, shall apply on a supplementary basis.

§ 2
Study Goals

(1) The master's degree course 'Infection Biology and Immunology' aims to educate graduates within the framework of a four-semester advanced degree course so that they can independently identify and structure questions in research and/or practice and answer them by selecting and applying suitable scientific methods. These goals are achieved with an educational programme directly related to research that also has significant practical components.

(2) Core modules on interdisciplinary topics should also enable graduates from other degree courses to gain an introduction to the topic and obtain knowledge about the principles of infection biology and immunology as well as OMICs technologies and data science. Key competences such as bioethics and laboratory animal science complement the basic knowledge taught.

(3) By combining various advanced modules that can be chosen freely, students can specialise in one of the named fields. During their studies, students receive broad methodological education that includes advanced biomedical laboratory methods in infection biology, immunology and modern OMICs technology as well as clinical research.

(4) In addition to the ability to implement the expert knowledge obtained as required by the specific problem, during their course students learn to reflect critically and analytically on complex matters. Based on the offered compulsory elective advanced modules with extensive research-oriented laboratory practicals, students are required to obtain an appropriate breadth of knowledge but are also able to specialise according to their individual strengths and interests. In doing so, the students acquire methodological knowledge and competences and can transfer principles of infection biology, immunology and biomedicine to specific problems.

(5) The research orientation and emphasis on independence in the education programme prepares students for work in scientific fields. The course aims to enable students to take on positions of responsibility in universities, research institutes, public authorities, and industry and commerce (e.g. pharmaceutical sector, clinical laboratories, medical technology). Students who complete the degree are also eligible to be accepted for a doctorate programme.

§ 3
Admission and Admission Requirements

(1) Studies in the master's degree course in Infection Biology and Immunology may be commenced in the winter semester.

(2) The admission requirements for the master's degree course are:

1. a successfully completed degree in a bachelor's degree course in biology, biochemistry or human biology or another successfully completed bachelor's degree course in the natural sciences with a connection to the content of the desired master's degree course; that bachelor's degree course must have a standard length of study of at least three years and include at least 60 ECTS in the subject biology, biotechnology, biochemistry or molecular medicine
2. proven proficiency in English at a level of at least B2 of the 'Common European Framework of Reference for Languages' or alternatively proof of at least seven years of English lessons at school as well as
3. proven proficiency in Germany at a level of at least B1.

§ 4
Structure of the Degree

(1) The master's course can be completed with the degree 'Master of Science' in four semesters (the standard length of study).

(2) The workload required to successfully complete the degree course totals 3,600 hours (120 ECTS). As part of the master's degree course 'Infection Biology and Immunology,' the following ECTS must be obtained for the individual modules:

- for the core modules: 36 ECTS (1,080 hours),
- for the advanced modules: 36 ECTS (1,080 hours),
- for the research practical module: 8 ECTS (240 hours),
- for the work placement module: 10 ECTS (300 hours),
- for the master's dissertation, including its defence: 30 ECTS (900 hours).

(3) The students have the right to independently design the temporal and organisational course of their studies. However, the core modules must be completed as a prerequisite for the advanced modules. The study plan described in the Appendix (sample study plan) is recommended. The sample study plans and the module catalogue should be consulted for the qualitative and quantitative relationships between the duration of the modules and the amount of ECTS on the one hand and the type of classes and number of contact hours per week on the other.

(4) A mobility window according to § 5(4) sentence 3 of the RPO exists after the second or third semester, depending on the chosen variation (Appendix A).

(5) The course of study is completed with the master's dissertation including defence (§ 11).

§ 5
Range and Types of Classes

(1) Successful studies requires student attendance in courses belonging to the core and advanced modules. The students are responsible for completing an appropriate amount of self-study.

(2) The course content of the modules is conveyed in the form of lectures, seminars, homework, exercises and practical lab courses. The courses are offered in English.

(3) Lectures serve to systematically present a subject matter and are mainly taught in the form of a presentation.

(4) Seminars serve to apply general content from a subject to specific problems and to practise presentation techniques. Students are introduced to independent academic work through presentations and discussions with teaching staff and fellow students. Attendance is mandatory for seminars.

(5) In practical lab courses or exercises, students shall be introduced to practical scientific activities under the close supervision of their lecturers. They convey basic methods of academic work in the relevant subject areas and support the application and in-depth exploration of the teaching content.

(6) Practical lab courses or exercises are characterised by the autonomous application of scientific methods to scientific problems. They serve the purpose of practising and deepening practical skills and promote the autonomous handling of academic tasks.

(7) Classes offered in several modules may only be taken once.

(8) The core and advanced modules are only offered once a year.

§ 6
Core modules

(1) Core modules convey the advanced general knowledge required for competent work on current issues in infection biology and immunology. They provide basic knowledge in the various fields of infection biology and immunology and applicable OMICs technologies, necessary key competences (bioethics, laboratory animal science) and data literacy.

(2) The following compulsory core modules are offered with a total of 36 ECTS (1,080 hours), all of which must be completed.

Core module 1 'Basics in Infection Biology' (CM1):

Type of course	**Contact hrs./ week (SWS)**
Practical lab course 'Fundamentals of Infection Biology' (PL)	4
Lecture series (L)	2
Seminar 'Infection Biology' (S)	1

Core module 2 'Immunology' (CM2):

Type of course	Contact hrs./ week (SWS)
Practical lab course 'Immunological Exercises' (PL)	4
Immunology (L)	2
Seminar 'Immunology' (S)	1

Core module 3 'Introduction to OMICs Technologies' (CM3):

Type of course	Contact hrs./ week (SWS)
Practical lab course 'OMICs Technologies' (PL)	4
Seminar 'Current Aspects of OMICs Technologies' (S)	1
Introduction to OMICs technologies (L)	2

Core module 4 'Applied Data Science' (CM4):

Type of course	Contact hrs./ week (SWS)
Applied Biostatistics with R (EX)	3
Data Literacy (EX)	1

Core module 5 'Key Competences' (CM5):

Type of course	Contact hrs./ week (SWS)
Bioethics and Laboratory Safety (L)	2
Laboratory Animal Science (L)	1
Laboratory Animal Science (EX)	1
Current Research in Infection Biology and Immunology (L) and Colloquium (L)	1

(3) The following examinations and non-assessed coursework must be completed for the core modules:

ID	Module	D	WL	ECTS	TE / C and SA	RED
CM1	Basics in Infection Biology	1	240	8	**TE:** WE60	1
					C: R + CA* Practical lab course	
					C: Pr Seminar	
CM2	Immunology	1	240	8	**TE:** WE60	1
					C: R + CA* Practical lab course	
					C: Pr Seminar	
CM3	Introduction to OMICs Technologies	1	240	8	**TE:** WE60	1
					C: CA* Practical lab course or CE	
					C: Pr* Seminar	
					C: PP or presentation on CE	
CM4	Applied Data Science	2	180	6	**C:** A test EX Applied Biostatistics with R	2
					C: CA* EX Data Literacy	
CM5	Key Competences	2	180	6	**TE:** WE60 or OE30	2
					C: R EX Laboratory Animal Science	

					C: CA* for at least 10 visits to the lecture series and colloquium	

§ 7
Advanced Modules

(1) The advanced modules serve to deepen the theoretical and practical knowledge in specific disciplines of infection biology and immunology with biomedical or clinical relevance. They also enable access to current research questions. In the compulsory-elective advanced modules, specific advanced knowledge and more complex methodological skills are taught from the biomedical, infectiological, immunological, technological, clinical or bioinformatics disciplines. This knowledge serves as preparation for the master's dissertation and qualification and specialisation related to the future profession.

(2) Participation in the practical courses offered as part of the advanced modules requires completion of the core modules CM1 to CM3. The lecturer of the respective course checks to make sure the required prerequisites are fulfilled.

(3) In the master's degree course 'Infection Biology and Immunology', the following compulsory-elective advanced modules (AM) are offered at a scope of 6 ECTS or 12 ECTS, and a total of 36 ECTS must be acquired. Students may complete further elective modules exceeding the minimum number of modules as additional courses (according to § 32 RPO) that shall also be listed on the transcript of records. These do not count towards the overall mark.

Advanced module 1 'Molecular Infection Biology' (AM1):

Type of course	**Contact hrs./ week (SWS)**
Molecular Basis of the Pathogenicity of Microorganisms (L)	2
Molecular Foundations of Cellular Microbiology and Bacterial Toxins (L)	2
Seminar 'Molecular Mechanisms of Pathogenicity' (S):	1
Practical lab course 'Molecular Infection Biology' (PL):	4

Module AM1 cannot be taken in combination with module AM2, i.e. only AM1 or AM2 may be selected as an advanced module.

Advanced module 2 'Host Genetics in Infectious Diseases' (AM2):

Type of course	**Contact hrs./ week (SWS)**
The Role of Host and Pathogen Genetics in Infectious Diseases (L)	2
Seminar 'Influence of Host Genetics on Infection Outcome' (S)	1
Practical lab course 'Host and Pathogen Genetics Determine the Infection Outcome' (PL)	4
Compulsory Elective	
Molecular Basis of the Pathogenicity of Microorganisms (L)	2

Molecular Foundations of Cellular Microbiology and Bacterial Toxins (L)	2

Module AM2 cannot be taken in combination with module AM1, i.e. only AM1 or AM2 may be selected as an advanced module.

Advanced module 3 'Molecular Virology and Cell Biology' (AM3):

Type of course	**Contact hrs./ week (SWS)**
Molecular / Cell Biological Aspects of Viral Infectious Diseases (L)	2
Seminar 'Molecular Basis of Viral Infection and Pathogenesis' (S)	1
Practical lab course 'Molecular Virology' (PL)	5

Advanced module 4 'One Health and Antimicrobial Resistance' (AM4):

Type of course	**Contact hrs./ week (SWS)**
One Health and Antimicrobial Resistance (L)	2
One Health and Antimicrobial Resistance (PL)	2.5
One Health and Antimicrobial Resistance (S)	1

Advanced module 5 'Infection Immunology' (AM5):

Type of course	**Contact hrs./ week (SWS)**
Cellular and Molecular Immunology of Infections (L)	2
Immune Responses, Immunopathology and Immune Intervention against Pathogenic Agents (L)	2
Seminar 'Immune Defence and Immunopathology in Infections' (s) or CE	1
Practical lab course 'Infectious Immunology' (PL)	4

Advanced module 6 'Clinical Module' (AM6):

Type of course	**Contact hrs./ week (SWS)**
Organ-Specific Infections and Clinical Immunology (L)	2
Clinical Immunology (L)	2
Seminar 'Molecular Mechanisms of Organ Damage Caused by Infection and Inflammation' (S)	1
Practical lab course 'Clinical Module' / 'Rounds' / 'Patient Presentation' (PL)	4

Advanced module 7 'Pathophysiology and Molecular Adaptation of Microbes' (AM7):

Type of course	**Contact hrs./ week (SWS)**
Molecular Microbiology and Gene Regulation (L)	3
Seminar 'Latest News in Molecular Microbiology' (S)	1
Practical lab course 'Molecular Microbiology' (PL)	4

Advanced module 8 'Microbial Pathoproteomics' (AM8):

Type of course	Contact hrs./ week (SWS)
Physiological Proteomics and Pathoproteomics of Microorganisms (L)	2
Seminar 'Pathoproteomics and Pathophysiology' (S)	1
Practical lab course 'Microbial Physiology/(Meta)-OMICs Studies' (PL)	5

Module AM8 cannot be taken in combination with module AM9, i.e. only AM8 or AM9 may be selected as an advanced module.

Advanced module 9 'Functional Genomics' (AM9):

Type of course	Contact hrs./ week (SWS)
Application of Functional Genomics (L)	2
Molecular Human Genetics (L)	1
Model Organisms and Methods of Functional Genomics (L)	1
Seminar 'New Aspects in the Field of Functional Genomics' (S)	1
Practical lab course 'Functional Genomics' (PL)	4

Module AM9 cannot be taken in combination with module AM8, i.e. only AM8 or AM9 may be selected as an advanced module.

Advanced module 10 'Biotechnology and Biophysics' (AM10):

Type of course	Contact hrs./ week (SWS)
Selected chapters on 'Fundamentals of Biotechnology and Protein Purification' and 'Structure-Function Studies of Proteins in Infection and Inflammation' as well as 'Biophysical Fundamentals of Infection Biology' (L)	2
Seminar 'Structure Elucidation and Biophysics in Infection Biology' (S)	1
Practical lab course 'Structural Elucidation in Infection Biology' (PL)	5

Advanced module 11 'Metabolomics in Infection Research' (AM11):

Type of course	Contact hrs./ week (SWS)
Metabolomics in Infection Research (L)	2
Seminar 'Recent Advances in Metabolomics in Infection and Immunology' (S)	2

Advanced module 12 (AM12) 'Microbiome in the One Health Context' (AM12):

Type of course	Contact hrs./ week (SWS)
Practical lab course 'Microbiome Research' (PL)	4
Selected Aspects of Microbiome Research I & II (L)	2
Taxonomy, Phylogeny and Diversity of Microorganisms (L)	1
Seminar 'Advances and Methods in Microbiome Research' (S)	1

Advanced Module 13 'Applied Bioinformatics' (AM13):

Type of course	Contact hrs./ week (SWS)
Lecture 'Applied Medical Bioinformatics' (L)	1
Exercises 'Applied Medical Bioinformatics' (EX)	2
Bioinformatics Programming (EX)	1

(4) The following examinations and non-assessed coursework must be completed for the advanced modules:

ID	Module	D	WL	ECTS	TE / C	RED
AM1	Molecular Infection Biology	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	2
AM2	Host Genetics in Infectious Diseases	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	2
AM3	Molecular Virology and Cell Biology	2	360	12	**TE:** WE60 or OE60 **C:** R + CA* Practical lab course **C:** Pr*	2
AM4	One Health und Antimicrobial Resistance	1	180	6	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	3
AM5	Infection Immunology	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr* or CE*	3
AM6	Clinical Module	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr* or CE*	2
AM7	Pathophysiology and Molecular Adaptation of Microbes	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	2
AM8	Microbial Pathoproteomics	2	360	12	**TE:** WE60 **C:** PP + CA* **C:** Pr*	3
AM9	Functional Genomics	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	2
AM10	Biotechnology and Biophysics	1	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	3
AM11	Metabolomics in Infection Research	1	180	6	**TE:** WE60 **C:** Pr*	2
AM12	Microbiome in the One Health Context	2	360	12	**TE:** WE60 **C:** R + CA* Practical lab course **C:** Pr*	1
AM13	Applied Bioinformatics	1	180	6	**C:** four tests EX+L Applied Medical Bioinformatics	2

					C: two tests EX Bioinformatics Programming	

§ 8
Research Practical Module

(1) The research practical with a duration of four weeks introduces students to current research topics in preparation for independent scientific work. It is to be carried out in the third semester in a scientific working group under the guidance of a member of the professorial staff involved in the master's course. Completing the research practical at another institution requires the approval of the Chairperson of the Examination Board. A report of 8 - 10 pages on the experiments carried out is to be submitted as an examination. This report is not marked. Proof of the practical is to be submitted in the form of an ungraded certificate from the host organisation. A total of 8 ECTS will be awarded.

(2) The research practical can be started if at least one advanced module has been completed in full.

§ 9
Work Placement Module

(1) The work placement of seven weeks' duration is intended to provide insights into possible professional fields and profiles of a graduate from the master's course in 'Infection Biology and Immunology' and provide experience in the organisational, social and professional structures of the supervising institution (business, public authority, research institute or similar). It serves to apply the acquired subject-specific and methodological knowledge in a possible occupational field and to obtain further additional and key qualifications related to the occupational field. 10 ECTS are awarded for the work placement.

(2) The work placement is to be organised independently by the student for the non-teaching period of the second or third semester.

(3) The work placement should be completed at research laboratories, companies or public institutions in Germany or abroad whose fields of activity are related to the study content and professional fields of the master's degree course. Upon the student's request, the Examination Board decides on the suitability of the work placement institution in good time before the start of the work placement. The request must be addressed to the Chairperson of the Examination Board and submitted in writing.

(4) As proof of the work placement, in addition to an unmarked certificate of participation from the work placement institution, a 4-page account of the work placement activity (report) with details of the tasks carried out during the course of the work placement must be submitted. This is assessed as "passed" or "failed" by the Chairperson of the Examination Board and another examiner. The final confirmation is made by the Chairperson of the Examination Board.

(5) Students remain enrolled at the University of Greifswald with all the rights and obligations of regular students during the period of the work placement. They are not interns as described in the *Berufsbildungsgesetz* (Vocational Training Act). Furthermore, students are bound by their work placement institution, in particular the health and safety regulations, the working time regulations and the regulations on confidentiality.

(6) Students are subject to the duty of confidentiality regarding official matters in accordance with the requirements of the work placement institution. This does not preclude preparing a report for study purposes. If the reports contain facts that are subject to confidentiality, they may only be published with the consent of the work placement institution.

§ 10
Examinations and Non-Assessed Coursework

(1) The master's examination consists of study-accompanying examinations for the individual modules and a master's dissertation including its defence.

(2) Module examinations serve the purpose of determining whether, and to what extent, the student has achieved the qualification objectives. Written examinations are assessed by one examiner; if it is the last resit attempt, a second examiner is to be consulted. Oral examinations are held before an examiner in the presence of a competent observer.

(3) Module examinations consist of individually separable types of examination. The different types of examination are:

- a 60-minute written exam (WE60)
- or alternatively a 30- or 60-minute oral examination (OE30 or OE60)

Examinations are held/submitted in English. They can also be held/submitted in German by agreement between the examiners and the students.

(4) Modules may also contain related, non-assessed coursework. Non-assessed coursework includes:

- unmarked experiment reports (R) on independently conducted exercises or practicals in a scope appropriate to the experiment (15-25 pages);
- unmarked coursework essays that serve to conduct an independent study of current literature and its summary in the form of a written paper (length: approx. 10-15 pages). The writing-up period for a coursework essay is two months.
- a 20-minute unmarked presentation (Pr) with subsequent discussion in the course of a seminar.
- poster presentations (PP), for which digital or printed posters are to be prepared and presented in a 20-minute discussion.
- tests in which the students' understanding of the content of the practical is checked by working on exercises between 4-8 pages each.

(5) If there is a choice between two types of examination, the lecturers shall determine the type of examination to be taken in the first week of lectures at the latest. If the

lecturer fails to define a type of examination, the examination will be a written examination.

(6) Written examinations and other examination documents remain with the examiner after assessment. Experiment reports are handed over to the students after being checked by the examiner.

§ 11
Compulsory Attendance

(1) In order to achieve the learning objective and receive credit points for a module, regular participation in the courses specified in §§ 6 and 7 is required. This is considered to be fulfilled if no more than 20% of the course is missed.

(2) If the students state and prove in writing that they are or have been absent for longer periods for reasons beyond their control (illness, care of a close relative who is sick or otherwise in need of assistance, pregnancy, death of a close relative), the Chairperson of the Examination Board shall decide whether the actual attendance time can still be counted as regular attendance. When considering the time of absence, submission of appropriate equivalent coursework for the coursework and examinations set down in §§ 6 and 7 may be required. The nature of this work is determined by the lecturer in consultation with the Chairperson of the Examination Board.

(3) For courses pursuant to subsection (1), an unmarked certificate of attendance (CA*) is a piece of non-assessed coursework issued in addition to any other examinations or non-assessed coursework. This must be passed in order for the credits to be awarded.

§ 12
Master’s Dissertation and Defence

(1) The master's dissertation is a written examination component that concludes the academic education. It is intended to demonstrate that students are able to independently work on a problem from their subject area using scientific methods and within a set period of time. The writing-up period is 840 hours over the course of six months. The dissertation is awarded 28 ECTS and the defence 2 ECTS.

(2) The master's dissertation demonstrates that students are able to successfully complete a given task in infection biology or immunology of limited, but nevertheless in-depth scope in the field of one of the areas listed below:

- Molecular Infection Biology
- Host Genetics in Infectious Diseases
- Virology and Cell Biology
- One Health and Antimicrobial Resistance
- Infectious Immunology
- Clinical Module
- Pathophysiology and Molecular Adaptation of Microorganisms
- Microbial Pathoproteomics
- Functional Genomics

- Biotechnology and Biophysics
- Metabolomics
- Microbiome Research
- Applied Bioinformatics

(3) Only those who have acquired at least 48 ECTS from the core and advanced modules and have successfully completed the research practical may request that the topic for the master's dissertation be allocated. The topic of the master's dissertation should be allocated at the beginning of the fourth semester but no later than six months after the completion of the last module examination. In the event that a student fails to apply for the topic or applies after the deadline, the writing-up period shall be shortened correspondingly.

(4) The master's dissertation must be defended. As part of the defence, the student must present the most significant aspects of the master's dissertation (15 minutes) and defend them against objections subsequently raised by the Examination Board (30 minutes). The defence of the master's dissertation shall be assessed by two examiners. One of the examiners should be the supervisor of the dissertation. If the defence is not passed, it may be repeated one time. If the defence is not passed second time round, the master's dissertation must also be repeated.

(5) An electronic version of the master's dissertation must be submitted at the same time as the printed version. At the same time, students must declare in writing that an electronic copy of the dissertation may be made and saved to enable review with anti-plagiarism software.

§ 13
Determination of the Overall Mark

(1) An overall mark is calculated for the master's examination. In accordance with §§ 26 and 33 RPO, the overall mark of the master's examination is calculated from the marks of the module examinations and the mark of the master's dissertation including its defence (§§ 30 and 31 RPO).

(2) The master's examination is passed when the student has acquired a total of 120 ECTS and has successfully completed all the required work according to § 4(2). The marks for the module examinations named in subsection (1) are included in the overall mark in accordance with their relative proportion of credits. The overall mark of the master's dissertation is weighted 1.5 times.

§ 14
Degree

After passing the master's examination, the degree 'Master of Science' (M.Sc.) shall be conferred.

§ 15
Entry into Force

(1) These Examination and Study Regulations shall enter into force on the day after their publication at the University.

(2) They shall only apply to students enrolled from winter semester 2022/2023 onwards.

Issued following the decision of the Study Committee of the Senate of 8 December 2021, which was granted the authorisation to pass decisions with the Senate decision of 20 May 2020 according to § 81(7) LHG and § 20(1) sentence 1 of the *Grundordnung* (Basic Regulations) and the approval of the Rector of 16 December 2021.

Greifswald, 16 December 2021

The Rector
of the University of Greifswald
University Professor Dr. Katharina Riedel

Publication note: Made public and accessible to all members of the University on 1 April 2022

Appendix A: Possible sample study plans for the master's degree course 'Infection Biology and Immunology'

The abbreviations have the following meanings: WE60, written exam (60 minutes); OE20/30, oral exam (20 or 30 minutes); R, report; Pr20, presentation on the seminar (20 minutes).

Without prejudice to the freedom of students to choose freely among the advanced modules (AM) offered, the study plans shown below represent sensible (albeit non-binding) module combinations. The core modules (CM) must be successfully completed by all students.

From the second semester onwards, advanced modules (AM) are chosen, of which at least 3 AM with a total of 36 ECTS must be selected. The four examples listed show sample study plans with different combinations of Advanced Modules (AM). Further combinations are possible due to the total of 13 possible AM. The selection and combination of AM is the students' own responsibility.

Example 1:

ID	Module Name	Classes	Contact hrs./week (SWS)	WL	ECTS	TE/SA	C	Semester
CM1	Basics in Infection Biology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM2	Immunology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM3	Introduction to OMICs Technologies	L, S, PL / CE	7 / 8	240	8	WE60	PP / CE, Pr20*, CA*	WiSe
CM4	Applied Data Science	2 EX	4	180	6		CA*, 1 test	WiSe / SuSe
CM5	Key Competences	4 L, EX	5	180	6	WE60 / OE 30	R, CA*	WiSe
AM1	Molecular Infection Biology	2 L, S, PL	9	360	12	WE60	R, Pr20*, CA*	SuSe
AM3	Molecular Virology and Cell Biology	L, S, PL	8	360	12	WE60 / OE60	R, Pr20*, CA*	SuSe
AM5	Infection Immunology	2 L, S, PL	9	360	12	WE60	R, Pr20* / CE*, CA*	WiSe
RP	Research Practical	PL	4 weeks	240	8		R (8-10 p)	WiSe / SuSe
WP	Work Placement	WP	8 weeks	300	10		R (4 p)	WiSe / SuSe
MD	Master's Dissertation		6 months	900	30	MD		WiSe / SuSe

Example 2:

ID	Module Name	Classes	Contact hrs./week (SWS)	WL	ECTS	TE/SA	C	Semester
CM1	Basics in Infection Biology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM2	Immunology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM3	Introduction to OMICS Technologies	L, S, PL / CE	7 / 8	240	8	WE60	PP / CE, Pr20*, CA*	WiSe
CM4	Applied Data Science	2 EX	4	180	6		CA*, 1 test	WiSe / SuSe
CM5	Key Competences	4 L, EX	5	180	6	WE60 / OE 30	R, CA*	WiSe
AM2	Host Genetics in Infectious Diseases	2 L, S, PL	9	360	12	WE60	R, Pr20*, CA*	SuSe
AM4	One Health und Antimicrobial Resistance	L, S, PL	5.5	180	6	WE60	R, Pr20*, CA*	WiSe
AM6	Clinical Module	2 L, S, PL	9	360	12	WE60	P, Pr20* or CE*, CA*	SuSe
AM11	Metabolomics in Infection Research	L, S	4	180	6	WE60	Pr20*, CA*	SuSe
RP	Research Practical	PL	4 weeks	240	8		R (8-10 p)	WiSe / SuSe
WP	Work Placement	WP	8 weeks	300	10		R (4 p)	WiSe / SuSe
MD	Master's Dissertation		6 months	900	30	MD		WiSe / SuSe

Example 3:

ID	Module Name	Classes	Contact hrs./week (SWS)	WL	ECTS	TE/SA	C	Semester
CM1	Basics in Infection Biology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM2	Immunology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM3	Introduction to OMICS Technologies	L, S, PL / CE	7 / 8	240	8	WE60	PP / CE, Pr20*, CA*	WiSe
CM4	Applied Data Science	2 EX	4	180	6		CA*, 1 test	WiSe / SuSe
CM5	Key Competences	4 L, EX	5	180	6	WE60 / OE30	R, CA*	WiSe
AM7	Pathophysiology and Molecular Adaptation of Microbes	L, S, PL	8	360	12	WE60	Pr20*, R, CA*	SuSe
AM9	Functional Genomics	3 L, S, PL	9	360	12	WE60	Pr20*, R, CA*	SuSe
AM10	Biotechnology and Biophysics	L, S, PL	8	360	12	WE60	R, Pr20*, CA*	WiSe
RP	Research Practical	PL	4 weeks	240	8		R (8-10 p)	WiSe / SuSe
WP	Work Placement	WP	8 weeks	300	10		R (4 p)	WiSe / SuSe
MD	Master's Dissertation		6 months	900	30	MD		WiSe / SuSe

Example 4:

ID	Module Name	Classes	Contact hrs./week (SWS)	WL	ECTS	TE/SA	C	Semester
CM1	Basics in Infection Biology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM2	Immunology	L, S, PL	7	240	8	WE60	Pr20*, R, CA*	WiSe
CM3	Introduction to OMICS Technologies	L, S, PL / CE	7 / 8	240	8	WE60	PP / CE, Pr20*, CA*	WiSe
CM4	Applied Data Science	2 EX	4	180	6		CA*, 1 test	WiSe / SuSe
CM5	Key Competences	4 L, EX	5	180	6	WE60 / OE30	R, CA*	WiSe
AM8	Microbial Pathoproteomics	L, S, PL	8	360	12	WE60	R, Pr20*, CA*	WiSe / SuSe
AM11	Metabolomics in Infection Research	L, S	4	180	6	WE60	Pr20*	SuSe
AM12	Microbiome in the One Health Context	2 L, S, PL	8	360	12	WE60	R, Pr20*, CA*	WiSe
AM13	Applied Bioinformatics	L, EX, PL	4	180	6		2 tests EX, 4 tests EX+L	SuSe
RP	Research Practical	PL	4 weeks	240	8		R (8-10 p)	WiSe / SuSe
WP	Work Placement	WP	8 weeks	300	10		R (4 p)	WiSe / SuSe
MD	Master's Dissertation		6 months	900	30	MD		WiSe / SuSe

Appendix B: Module catalogue for the international master's degree course ‘Infection Biology and Immunology’ at the University of Greifswald

List of Abbreviations

AM	Advanced module
C	Coursework
CA	Confirmation of attendance
CE	Coursework essay
CEE	Compulsory elective examination
CM	Core module
ECTS	Credits according to the European Credit Transfer System
EX	Exercises
L	Lecture
M	Minutes
MD	Master’s dissertation
OE	Oral examination
PL	Practical lab course
PP	Poster presentation
Pr	Presentation
R	Report
S	Seminar
SuSe	Summer semester
SWS	Contact hours per week
TE	Type of examination
WE	Written examination
WiSe	Winter semester
WP	Work placement

-	Until
*	Unmarked examination/coursework
/	Or

General overview:

The curriculum of the M. Sc. degree course ‘Infection Biology and Immunology’ is structured as follows:

- 5 basic modules (BM) are offered, all of which must be completed (36 ECTS in total).
- 13 advanced modules are offered, in which 36 ECTS are to be acquired.
- 1 research practical that expands on specific experimental content of one of the chosen advanced modules (8 ECTS).
- 1 work placement (10 ECTS).
- 1 master's dissertation including defence, which deals with a more comprehensive problem from the area of one of the selected advanced modules (30 ECTS).

Core modules:

Core module 1 (CM1) 'Basics in Infection Biology'	
Responsible	Professors and staff of the Department of Molecular Genetics and Infection Biology of the Interfaculty Institute of Genetics and Functional Genomics (MNF) and the Institute of Pharmacy, the Institutes of Molecular Virology and Cell Biology, of Infectious Medicine and of New and Novel Animal Pathogens and of Immunology, Friedrich Loeffler Institute Riems, the Institute of Medical Microbiology (UMG)
Language	English
Module objectives	▪ History of infectious diseases ▪ Introduction to viruses, bacteria, fungi, parasites ▪ Basic knowledge of epidemiology and pandemics ▪ Basic knowledge of pathogen-host interactions ▪ Spread of antibiotic resistance ▪ Emerging pathogens ▪ Basic knowledge in methods of infection biology
Module contents	**Lecture series:** ▪ History of infectious diseases ▪ Epidemics and pandemics ▪ Extracellular bacterial pathogens ▪ Intracellular bacterial pathogens ▪ Paradigm staphylococci ▪ Tuberculous and atypical mycobacteria ▪ Skin and wound infections due to bacteria ▪ Pathogenic fungi ▪ Parasites ▪ Vector-borne pathogens ▪ Sexually transmitted pathogens ▪ Viral pathogens ▪ Emerging pathogens ▪ Fundamentals of antibiotic resistance **Literature seminar 'Fundamentals of Infection Biology':** ▪ Literature research on current topics in infection biology and immunology ▪ Elaboration of basic infection biology seminars in textual and illustrated presentation as well as presentation and discussion of the literature study **Practical lab course 'Fundamentals of Infection Biology':** ▪ Active participation in current research projects of the participating institutes

Classes (in ECTS and SWS)	8 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Lecture series (L; 2 SWS) ▪ Literature seminar (S; 1 SWS) ▪ Practical lab course (PL; 4 SWS)	30 15 60	135	240
Assessment components	▪ Assessment: Written exam (WE60) on the contents of the lectures ▪ C: regular participation in the practical lab course (CA*) ▪ C: Submission of a report on the practical lab course* ▪ C: Presentation* 20M in the literature seminar and scientific discussion in the seminar lectures (according to the announcement at the beginning of the course)			
On offer	Annually in the winter semester			
Duration	1 semester			
Regular examination date	1st semester			
Recommended previous knowledge	Basics of genetics, microbiology and molecular biology			

Core module 2 (CM2) 'Immunology'	
Responsible	Professors and staff of the Department of Immunology and the Friedrich Loeffler Institute of Medical Microbiology - Virology, UMG
Language	English
Module objectives	▪ More in-depth understanding of the concepts of immunology ▪ Practice of the ability to understand original works in English, to identify important content, to present this content and to discuss it critically ▪ Knowledge of the possibilities and limitations of important immunological methods that is ready to be applied in practice ▪ Skill in performing basic immunological laboratory methods
	Lecture 'Immunology': ▪ Introduction ▪ Innate immune system o Cellular receptors and effector mechanisms o Complement o Neutrophil granulocytes o ILCs including NK cells ▪ Adaptive immune system

<table>
<tr><td></td><td colspan="4">

B cells and antibodies
Antigen presentation and T cells
Immune memory
Central tolerance
Peripheral tolerance

Immunopathology
Autoimmune diseases
Allergies

Seminar ‘Immunology’:

Going more in-depth into the knowledge from the lecture
Presentation and critical discussion of an original English-language paper

Practical lab course ‘Immunological Exercises’:

Antibody purification and enzymatic cleavage
Isolation and activation of immune cells
Analysis of different lymphocyte populations (staining and flow cytometric analysis)
Cytokine production (multiplex assay)
Cell proliferation (CFSE)
Induction and detection of apoptosis (western blot)
Immunohistochemistry
Design and implementation of an experiment for an infection immunology question

</td></tr>
<tr><td>Classes
(in ECTS, SWS and h)</td><td>8 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td></td><td>▪ Immunology (L; 2 SWS)
▪ Literature seminar ‘Immunology’ (S; 1 SWS)
▪ Practical lab course ‘Immunological Exercises’ (PL; 4 SWS)</td><td>30
15

60</td><td>135</td><td>240</td></tr>
<tr><td>Assessment components</td><td colspan="4">

TE: Written exam (WE60) on the contents of the lecture and seminar
C: regular participation in the practical lab course (CA*)
C: Submission of a report on the practical lab course*
C: Presentation* 20M in the literature seminar and scientific discussion during the seminar presentations (according to the announcement at the beginning of the course)

</td></tr>
<tr><td>On offer</td><td colspan="4">Annually, in winter semester</td></tr>
<tr><td>Duration</td><td colspan="4">1 semester</td></tr>
<tr><td>Regular examination date</td><td colspan="4">1st semester</td></tr>
</table>

Recommended previous knowledge	Basic knowledge of immunology

Core module 3 (CM3) 'Introduction to OMICs Technologies'				
Responsible	Professors and staff of the Institute of Microbiology, the Interfaculty Institute of Genetics and Functional Genomics, the Institute of Pharmacy, the Institute of Biochemistry			
Language	English			
Module objectives	▪ Theoretical and practical knowledge of OMICs technologies in current infection research ▪ Knowledge of the application of OMICs technologies in medical microbiology and in pathophysiological questions			
Module contents	**Lecture 'Introduction to OMICs technologies'** ▪ General overview of OMICs technologies ▪ Technical and methodological basics of genome sequencing and analysis, metagenomics, transcriptome, proteome and metabolome analysis ▪ Basics of the analysis of OMICs data **Seminar 'Current Aspects of OMICs Technologies'** ▪ Going more in-depth into the knowledge acquired from the lecture and practical lab course ▪ Study of current scientific literature covering specific aspects, milestones and recent developments in OMICs-based research ▪ Presentation and discussion of scientific literature and research results **A choice can be made between the coursework essay and the practical lab course:** **Coursework essay 'Current aspects of OMICs technologies'** ▪ Coursework essay on a topic concerning specific aspects and current developments in OMICs-based research **or** **Practical lab course 'OMICs Technologies'** ▪ Active participation in current research projects of the participating institutes			
Classes (in ECTS, SWS and h)	8 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Introduction to OMICs Technologies (L; 2 SWS) ▪ Current Aspects of OMICs Technologies (S; 1 SWS)	30 15	135	240

	▪ OMICs Technologies (PL; 4 SWS) **or** ▪ Written assignment (coursework essay) (4 SWS)	60		
Assessment components	▪ TE: Written examination (WE60) on the contents of the lecture ▪ C: regular participation in the practical lab course (CA*) or written assignment (CE) 10-15 p. (coursework essay*) ▪ C: Presentation* 20M on a selected scientific publication as part of the seminar and scientific discussion during the seminar presentations* ▪ C: Presentation of a digital poster on the research findings from the practical lab course or the coursework essay*			
On offer	Annually, in winter semester			
Duration	1 semester			
Regular examination date	1st semester			
Recommended previous knowledge	Basic knowledge of microbiology, biochemistry and genetics			

Core module 4 (CM4) 'Applied Data Science'	
Responsible	Professors and staff of the Institute of Bioinformatics at UMG and the Bioinformatics Working Group of the Institute of Mathematics and Computer Science
Language	English
Module objectives	▪ Comprehensive introduction of biostatistical methods on medical data sets with a focus on research and application ▪ Further training in statistical methods ▪ Competent application of these methods (e.g. statistical test procedures, correlation analysis, regression analysis) by using the statistical software R and RStudio ▪ Programming language Python
Module contents	**Course 'Applied Biostatistics with R':** ▪ Recapitulation of basic concepts of statistics ▪ Competence in the application of parametric and non-parametric methods in the analysis of categorical, continuous and paired data ▪ Competence in checking the requirements for using statistical methods ▪ Knowledge in dealing with missing values in the data

<table>
<tr><td></td><td colspan="4">▪ Competence in handling event time data
▪ Basic knowledge of model diagnostics (validation techniques and comparison of regression models) as a prerequisite for a valid interpretation of the results of statistical tests
▪ Competence in publishing statistical results
▪ Basic knowledge of study and case planning
▪ Competence in handling R and RStudio

Exercises ‘Data Literacy’:
One of the following data literacy courses:
▪ ‘Introduction to Programming with Python’ (suitable for students without Python programming knowledge)
▪ ‘Python Programming for Advanced Students’ (suitable for students with basic Python knowledge)
▪ ‘Machine Learning for Users’ (suitable for students with basic Python knowledge).</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>6 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Course ‘Applied Biostatistics with R’ (EX; 3 SWS)
▪ Exercises ‘Data Literacy’ (EX; 1 SWS)</td><td>45

15</td><td>120</td><td>180</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ C: Regular participation in the exercises Data Literacy (CA*)
▪ C: Regular participation in the course Applied Biostatistics with R (CA*)</td></tr>
<tr><td>On offer</td><td colspan="4">Annually (‘Data Literacy’ courses in the winter semester break, ‘Applied Biostatistics with R’ in the summer semester)</td></tr>
<tr><td>Duration</td><td colspan="4">2 semesters (WiSe and SuSe)</td></tr>
<tr><td>Regular examination date</td><td colspan="4">2nd semester</td></tr>
<tr><td>Recommended previous knowledge</td><td colspan="4">Biometry or statistics</td></tr>
</table>

Core module 5 (BM5) ‘Key Competences’	
Responsible	Professors and staff of the Institutes of Ethics and History of Medicine, Physiology and cooperating institutes, the Interfaculty Institute of Genetics and Functional Genomics and Immunology
Language	English
Module contents	**Lecture part I ‘Bioethics’:** ▪ Historical development and social relevance of bioethics ▪ Basic concepts of bioethics

<table>
<tr><td></td><td colspan="4">

Approaches of bioethical theories
Topics of bioethics
Basic issues of animal ethics
Classical theories and positions
Ethical considerations in the animal experiment applications
Historical examples of ethically questionable research
Principles of research ethics reflection
Guidelines and codes for biomedical research

Lecture part II ‘Laboratory Safety’:

Handling radioisotopes
Handling hazardous substances
Handling genetically modified organisms
Handling infectious agents

Lecture part III ‘Laboratory Animal Science’:

Legal requirements and ethical problems
Physiology of important laboratory animal species (vertebrates)
Standardisation and health control
Spontaneous and induced disease models
Genetically modified organisms
Procedures in animal experiments
Planning and design of animal experiments
Occupational health and safety
Alternative methods to animal experimentation

Lecture part IV ‘Current Research in Infection Biology and Immunology’:

Lecturers report on their current research projects

Colloquium ‘Microbiological-Infectiological Colloquium’:

Invited national and international researchers report on their current research topics

</td></tr>
<tr><td>Classes
(in ECTS, SWS and h)</td><td>6 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td></td><td>

Ethics (L) & Laboratory Safety (L) (2 SWS)
Laboratory Animal Science (L; EX; 2 SWS)
Current Research in Infection Biology and Immunology (L) (1 SWS) & Colloquium (L) (1 SWS)

</td><td>30
30
30</td><td>90</td><td>180</td></tr>
</table>

Assessment components	▪ TE: Written examination (WE60) or oral examination (OE30) on the contents of the lectures 'Laboratory Animal Science' and 'Bioethics' ▪ C: Report on the exercises for Laboratory Animal Science ▪ C: Participation in at least 10 individual lectures belonging to the lecture series and 10 classes as part of the colloquium* (CA*)
On offer	Summer semester and winter semester
Duration	2 semesters
Regular examination date	2nd semester
Recommended previous knowledge	Basic knowledge of genetics, microbiology and physiology

Advanced Modules:

Advanced module 1 'Molecular Infection Biology' (AM1)	
Responsible	Professors and staff of the Department of Molecular Genetics and Infection Biology of the Interfaculty Institute of Genetics and Functional Genomics, MNF
Language	English
Module contents	**Lecture 'Molecular Basis of the Pathogenicity of Microorganisms':** ▪ Evolution of pathogenicity and genomic islands ▪ Molecular mechanisms of pathogen-pathogen interaction ▪ Regulation of virulence factors, phase variation, antigen variation ▪ Biofilm formation due to pathogenic microorganisms ▪ Molecular mechanisms of immune evasion of infectious agents ▪ Pathogens and their interaction with platelets ▪ Bacteriophages and application in medicine ▪ Bacterial vaccines and the new generation of bacterial vaccines **Lecture 'Molecular Foundations of Cellular Microbiology and Bacterial Toxins':** ▪ The extracellular matrix and pathogenic agents ▪ Dynamics of the cytoskeleton ▪ Intracellular pathogens and molecular strategies of dissemination ▪ Activation of integrins by bacteria or bacterial effectors and bacterial induction of the molecules of the focal adhesion complexes

<table>
<tr><td></td><td colspan="4">▪ Adherence and tight junctions and bacterial internalisation
▪ Signal transduction pathways and bacterial internalisation
▪ Structure-function relationships of prokaryotic toxins
▪ Molecular and atomic basis of the receptor specificity of toxins
▪ AB toxins, their mechanisms of action and cellular targets
▪ Internalised toxins

Seminar ‘Molecular Mechanisms of Pathogenicity’:
▪ Consolidation of the knowledge acquired in the lecture
▪ Literature research on current issues of molecular and microbial pathogenicity
▪ Elaboration of the central findings in textual and illustrated depiction as well as presentation and discussion of the studies

Practical lab course ‘Molecular Infection Biology’:
▪ Adherence and phagocytosis of bacteria
▪ Investigation of pathogen-host interaction through protein-protein interactions in binding experiments (flow cytometry and protein-protein functional studies)
▪ Biofilm formation by streptococci/staphylococci on epithelial substrate
▪ Analysis of host response, cell integrity and cytotoxicity in infected host cells (cadherin, interleukin, LDH)
▪ Signal transduction in infected host cells
▪ Experiments with primary blood cells and characterisation by microscopy and FACS</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Molecular Basis of the Pathogenicity of Microorganisms (L; 2 SWS)
▪ Molecular Foundations of Cellular Microbiology and Bacterial Toxins (L; 2 SWS)
▪ Literature seminar ‘Molecular Mechanisms of Pathogenicity’ (S; 1 SWS)
▪ Practical lab course ‘Molecular Infection Biology’ (PL; 4 SWS)</td><td>30
30
15
60</td><td>225</td><td>360</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ TE: Written examination (WE60) on the contents of the lectures ‘Molecular Basis of the Pathogenicity of</td></tr>
</table>

	Microorganisms' and 'Molecular Foundations of Cellular Microbiology and Bacterial Toxins' ▪ C: regular participation in the practical lab course (CA*) ▪ C: Submission of a report on the practical lab course* ▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations* (according to the announcement at the beginning of the course)
On offer	Annually, in summer semester
Duration	1 semester
Regular examination date	2nd semester
Module can be selected for	M.Sc. Biochemistry, M.Sc. Molecular Biology and Physiology
Recommended previous knowledge	Knowledge of biochemistry, molecular genetics and microbiology, CM1, CM2, CM5

Advanced module 2 (AM2) 'Host Genetics in Infectious Diseases'	
Responsible	Professors and staff of the Department of Molecular Genetics and Infection Biology of the Interfaculty Institute of Genetics and Functional Genomics, MNF
Language	English
Module contents	**Lecture: 'The Role of Host and Pathogen Genetics in Infectious Diseases':** ▪ Host genetic and environmental risk factors in infectious diseases ▪ Genetic architecture of infectious diseases ▪ Immunogenetics and molecular basis for differences in outcomes of invasive infections ▪ Manipulation of the host immune system by pathogens **Seminar: 'Influence of Host Genetics on Infection Outcome'** ▪ Literature research on current topics in immunogenetics of infectious diseases ▪ Preparation of the presentation ▪ Presentation of the main results of the peer-reviewed article ▪ Discussion of the results during the seminar **Practical lab course 'Host and Pathogen Genetics Determine the Infection Outcome':** ▪ Comparative analyses of the infection result of a genetically identical cell line (antibiotic protection assay, microscopy, ELISA, western blot)

<table>
<tr><td></td><td colspan="4">▪ Analyses of cells expressing molecules of the protective and non-protective phenotype (RNA isolation; cDNA synthesis, PCR for genotyping, phenotypic characterisation by flow cytometry and western blot)
▪ Infection of human cells with protective and non-protective phenotype with a bacterial clone (flow cytometry and ELISA)

Compulsory Elective (CE) one of the following lectures from the module ‘Molecular Infection Biology’ has to be chosen:
▪ Lecture: ‘Molecular Basis of the Pathogenicity of Microorganisms’
or
▪ Lecture: ‘Molecular Foundations of Cellular Microbiology and Bacterial Toxins’</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ The Role of Host and Pathogen Genetics in Infectious Diseases (L; 2 SWS)
▪ Influence of Host Genetics on Infection Outcome (S; 1 SWS)
▪ Host and Pathogen Genetics Determine the Infection Outcome (full-time, large-scale PL; 4 SWS)

Compulsory elective course - one of either lectures:
▪ Molecular Basis of the Pathogenicity of Microorganisms (L; 2 SWS)
or
▪ Molecular Foundations of Cellular Microbiology and Bacterial Toxins (L; 2 SWS)</td><td>30
15
60

30</td><td>225</td><td>360</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ TE: Written examination (WE60) on the contents of 2 lectures (WE60)
▪ C: regular participation in the practical lab course (CA*)
▪ C: Submission of a report on the practical lab course*</td></tr>
</table>

	▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations* (according to the announcement at the beginning of the course)
On offer	Annually, in summer semester
Duration	1 semester
Regular examination date	2nd semester
Recommended previous knowledge	Eukaryotic and prokaryotic genetics, pathogenicity, CM1, CM2, CM5

Advanced module 3 (AM3) 'Molecular Virology and Cell Biology'	
Responsible	Professors and staff of the Institutes of Molecular Virology and Cell Biology, of Infectious Medicine and of Novel and Emerging Animal Pathogens, Friedrich Loeffler Institute Riems
Language	English
Module contents	**Lecture 'Molecular / Cell Biological Aspects of Viral Infectious Diseases':** ▪ Principles of the molecular biology of viruses ▪ Host cell functions in virological infection processes ▪ Virus interactions / interference with cellular signalling cascades and functions. ▪ Methods for studying viral biology and virus-host interactions (e.g. imaging techniques, reverse genetics, complex primary cell culture systems, protein and nucleic acid analysis). ▪ Molecular basis of zoonotic viruses. **Seminar 'Molecular Basis of Viral Infection and Pathogenesis':** ▪ Literature research on current issues of molecular and viral pathogenesis. ▪ Oral presentation of students' own research using relevant examples / key experiments from original scientific papers. **Practical lab course 'Molecular Virology':** ▪ Basic methods for manipulating viral sequences/proteins and competence for designing experimental approaches using relevant software (e.g. cloning of ORFs by PCR, PCR variants, primer design, subcloning, generation of deletion mutants, site-directed mutagenesis, sequencing, cloning strategies). ▪ Modern cloning methods.

	▪ Principles of basic virological methods (infection, titration). ▪ Knowledge of immunofluorescence analysis and assay optimisation parameters. ▪ Advanced bioimaging of infection processes in organoid models and organs/tissues with digital data processing.			
Classes (in ECTS, SWS and h)	12 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Molecular / Cell Biological Aspects of Viral Infectious Diseases (L; 2 SWS) ▪ Literature seminar Molecular Basis of Viral Infection and Pathogenesis (S; 1 SWS) ▪ Practical lab course 'Molecular Virology' (PL; 5 SWS)	30 15 75	240	360
Assessment components	▪ TE: Written examination (WE60) or oral examination (OE60) on the lecture 'Molecular / Cell Biological Aspects of Viral Infectious Diseases' ▪ C: regular participation in the practical lab course (CA*) ▪ C: Submission of a report on the practical lab course* ▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*			
On offer	Annually, in summer semester (lecture and practical lab course in summer semester, seminar in winter semester)			
Duration	2 semesters			
Regular examination date	Written examination in the 2nd semester (summer semester), completion of module in 3rd semester (winter semester)			
Module can be selected for	M.Sc. Human Biology, M.Sc. Molecular Biology and Physiology			
Recommended previous knowledge	Basic knowledge of virology, microbiology, cell biology or molecular biology, CM1, CM2			

Advanced module 4 (AM4) "One Health and Antimicrobial Resistance'	
Responsible	Professors and staff of the working group 'Pharmaceutical Biology' of the Institute of Pharmacy, the Friedrich Loeffler Institute for Medical Microbiology, the Helmholtz Institute for One Health (HIOH) and the Institute for Infection Medicine of the Friedrich Loeffler Institute

Language	English
Module contents	**Lecture:** ▪ Overview of antibiotics and anti-infectives ▪ Plants, algae and fungi as sources of natural substances with antibiotic, anti-infective and immunomodulating effects ▪ Biological basis of bacterial resistance development ▪ Multi-resistant germs (so-called ESKAPE pathogens) and their resistance mechanisms with a focus on ESBL and carbapenemase-producing Enterobacteriaceae as well as MRSA ▪ Non-resistance mechanisms of multidrug-resistant germs such as virulence and fitness and their contribution to the success of bacterial clonal lineages ▪ Molecular epidemiology of multi-resistant germs in the One Health context and as zoonotic pathogens (specific case studies, e.g. the occurrence of certain antibiotic-resistant *E. coli* sequence types in patients, wild and domestic animals) ▪ Bloodsucking arthropods as potential vectors of animal disease and zoonotic pathogens and their resistance development ▪ Basics of the interactions between pathogen and host or vector as a basis for the development of immunoprophylactic measures, specific and sensitive animal disease diagnostics and efficient control strategies ▪ Further application examples for the whole genome analysis of bacterial pathogens (e.g. phylogenetic comparisons, outbreak events in hospitals) (basics of whole genome analysis is to be taught within the core module CM3 "OMICs") ▪ Alternative therapeutic strategies and identification of novel lead structures against multi-resistant germs **Practical lab course:** ▪ Preparation of bacterial cultures on chromogenic nutrient agar plates for differentiation of ESKAPE pathogens (dilution smear, plating, assessment of colony morphology) ▪ Phenotypic antibiotic resistance characterisation (microdilution method, agar diffusion test) ▪ DNA and plasmid extraction ▪ Genotypic detection of resistance and virulence genes (PCR, multiplex PCR) ▪ Plasmid profile analysis of resistance plasmids

	▪ Initial phylogenetic classification as well as genomic resistance and virulence characterisation by means of whole genome analysis (demonstration of the creation of a phylogenetic tree in the One Health context, use of specific software programmes) **Literature seminar 'Antimicrobial Resistance in the One Health Context':** ▪ Literature research on current topics of the spread of resistant germs in humans, animals and the environment ▪ Elaboration of basic seminars in textual and illustrated depiction as well as presentation and discussion of the literature data

Classes (in ECTS, SWS and h)	6 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Lecture (L; 2 SWS) ▪ Practical lab course (PL; 2.5 SWS) ▪ Literature seminar (S; 1 SWS)	30 37.5 15	97.5	180
Assessment components	▪ TE: Written examination (WE60) on the contents of the lecture ▪ C: regular participation in the practical lab course (CA*) ▪ C: Submission of a report on the practical lab course* ▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*			
On offer	Annually, in winter semester			
Duration	1 semester			
Regular examination date	3rd semester			
Recommended previous knowledge	Basic general knowledge of microbiology, CM1, CM3, CM5			

Advanced module 5 (AM5) 'Infection Immunology'	
Responsible	Professors and staff of the Institute of Immunology, Friedrich Loeffler Institute Riems
Language	English
	Lecture 'Cellular and Molecular Immunology of Infections': ▪ Interaction between pathogens and immune cells

	▪ Recognition of pathogen-associated danger and stress patterns induced by pathogens ▪ Activation, differentiation and maturation of immune cells upon pathogen contact ▪ Immune subversion in bacterial, viral and parasitic infections ▪ Reprogramming of infected immune cells in bacterial, viral and parasitic infections ▪ Role of cell stress, necrosis, apoptosis and autophagy during infection and defence ▪ Interaction between cell autonomous, innate and adaptive immunity with regard to the evolution of the immune system **Lecture 'Immune Responses, Immunopathology and Immune Intervention against Pathogenic Agents':** ▪ Inflammatory reactions and inflammation-associated defence mechanisms ▪ Immunological strategies of pathogen elimination and MHC-mediated antigen presentation ▪ Plasticity of the immune system (using the example of macrophages and T cells) in chronic infections ▪ Immune memory ▪ Immune response in bacterial infections ▪ Immune subversion in bacterial infections ▪ Immune response in viral infections ▪ Immune subversion in viral infections ▪ Vaccination strategies and host-based therapies for zoonotic diseases **Practical lab course 'Infectious Immunology':** ▪ Cellular infection studies (bacterial and viral pathogens under S2 conditions) ▪ Flow cytometry (characterisation of cells after pathogen contact & infection) ▪ Microscopy and automated cellular imaging (description of immune cell-pathogen interactions) ▪ Bioenergetic flux analyses (representation of metabolic processes during immune cell-pathogen interactions) ▪ ELISA & ELISPOT (description of immunological communication processes and cellular activation stages during & after pathogen detection) ▪ Reporter-based assays using luminescence / fluorescence (characterisation of signalling pathways and anti-microbial activity of immune cells) **Seminar 'Immune Defence and Immunopathology in Infections':**

<table>
<tr><td></td><td colspan="4">▪ Literature research on current issues of immunological processes in zoonotic diseases
▪ Consolidation of the knowledge acquired in the lecture
▪ Presentation and discussion of the studies</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Lecture ‘Cellular and Molecular Immunology of Infections’ (L; 2 SWS)
▪ Lecture ‘Immune Responses, Immunopathology and Immune Intervention against Pathogenic Agents’ (L; 2 SWS)
▪ Literature seminar ‘Immune Defence and Immunopathology in Infections’ (S; 1 SWS)
▪ Practical lab course ‘Infectious Immunology’ (PL; 4 SWS)</td><td>30
30
15
60</td><td>225</td><td>360</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ TE: Written examination (WE60) on the contents of both lectures and the seminar
▪ C: regular participation in the practical lab course (CA*)
▪ C: Submission of a report on the practical lab course*
▪ C: Presentation* 20M in or coursework essay on the literature seminar and scientific discussion during the seminar presentations (according to the announcement at the beginning of the course)</td></tr>
<tr><td>On offer</td><td colspan="4">Annually, in winter semester</td></tr>
<tr><td>Duration</td><td colspan="4">1 semester</td></tr>
<tr><td>Regular examination date</td><td colspan="4">3rd semester</td></tr>
<tr><td>Recommended previous knowledge</td><td colspan="4">Knowledge of immunology & cell biology & microbiology, CM1, CM2, CM5</td></tr>
</table>

Advanced module 6 (AM6) ‘Clinical Module’	
Responsible	Professors and staff of the Clinic and Polyclinic for Internal Medicine A, the Clinic and Polyclinic for Internal Medicine B, the Clinic and Polyclinic for Orthopaedics and Orthopaedic Surgery, the Clinic and Polyclinic for Urology, the Clinic and Polyclinic for Neurology, and the Institute for Immunology
Language	English

<table>
<tr><td>Module contents</td><td colspan="4">Lecture ‘Organ-Specific Infections’:
▪ Pneumonia
▪ Infections in orthopaedics
▪ Infectious diarrhoeal diseases
▪ Viral hepatitis
▪ Infections of the urogenital tract
▪ Infections of the central nervous system
▪ Endocarditis
▪ Sepsis
▪ Inflammation-related cardiac and skeletal muscle damage
▪ Chronic inflammatory diseases
▪ Transplantation

Lecture ‘Clinical Immunology’:
▪ The immune system in the entire organism
▪ Immune system and metabolism
▪ Reproductive immunology
▪ Chronic inflammatory diseases (allergies, autoinflammatory diseases, autoimmune diseases)
▪ Transplantation immunology
▪ Tumour immunology
▪ Immune control of bacteria, viruses, fungi and parasites
▪ Generalised infections, sepsis
▪ Immunodeficiencies
▪ Immune interventions

Seminar ‘Molecular Mechanisms of Organ Damage Caused by Infection and Inflammation’:
▪ Literature research on health policy relevant and current problems of infections and inflammations (e.g. pneumonia, sepsis, consequences of intensive care).
▪ Elaboration of the central findings in textual and illustrated depiction with limited scope.

Practical lab course ‘Clinical Module’ / ‘Rounds’ / ‘Patient Presentation’:
▪ Bedside rounds by the clinics involved.
▪ Blood count analyses (staining and measurement of own blood samples); evaluation of measurement data from patients with immunodeficiencies or haematological diseases.</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Organ-Specific Infections and Clinical Immunology (L; 2 SWS)
▪ Clinical Immunology (L; 2 SWS)
▪ Literature seminar</td><td>30

30</td><td>225</td><td>360</td></tr>
</table>

	‘Molecular Mechanisms of Organ Damage Caused by Infection and Inflammation’ (S; 1 SWS) ▪ Practical lab course ‘Clinical Module’ / ‘Rounds’ / ‘Patient Presentation’ (PL; 4 SWS)	15 60		
Assessment components	▪ TE: Written examination (WE60) on the contents of all lectures ▪ C: Regular participation in the patient presentation rounds (CA*) ▪ Submission of a report* ▪ C: Presentation* 20M in or coursework essay* on the seminar and scientific discussion during the seminar presentations (according to the announcement at the beginning of the course)			
On offer	Annually, in summer semester			
Duration	1 semester			
Regular examination date	2nd semester			
Recommended previous knowledge	In-depth knowledge of infection biology, CM1, CM2, CM5			

Advanced module 7 (AM7) ‘Pathophysiology and Molecular Adaptation of Microbes’	
Responsible	Professors and staff of the Departments of Functional Genomics (Interfaculty Institute of Genetics and Functional Genomics) and Microbial Physiology and Molecular Biology (Institute of Microbiology)
Language	English
Module contents	**Lecture ‘Molecular Microbiology and Gene Regulation’:** ▪ Signal transduction and gene regulation: Adaptation to nutrient deficiency, metal regulation, other ecophysiologically relevant stress factors (oxidative stress, osmostress, phages), function of regulatory nucleotides, bistable gene expression ▪ Function of regulatory RNAs ▪ Species concept, diversity, symbioses, adaptation mechanisms, molecular methods, metagenomics & metaproteomics ▪ Molecular mechanisms of microbial pathogenicity: biofilms & quorum sensing, persisters, antimicrobial

<table>
<tr><td></td><td colspan="4">therapy & resistance mechanisms, pathogen-microbiome-host interactions
▪ Microbial volatiles, regulatory processes at the membrane

Seminar ‘Latest News in Molecular Microbiology’:
▪ Consolidation of the knowledge acquired in the lecture
▪ Study of selected current scientific literature on the subject area of molecular microbiology and gene regulation
▪ Presentation and discussion of current research results

Practical lab course ‘Molecular Microbiology’:
▪ Regulation of gene expression, enzymes and isoenzymes, use of reporter gene systems
▪ Radioactive isotopes and click chemistry in bacterial physiology and molecular microbiology (incorporation experiments to determine RNA and protein syntheses, determination of the half-life of RNA)
▪ Molecular biology/genetic engineering (PCR, cloning, blue/white screening in E. coli, mutant construction in B. subtilis, northern blot analyses, overexpression of recombinant proteins in E. coli)
▪ Bacterial genomes (databases, bioinformatic analysis of bacterial genomes)</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Molecular Microbiology and Gene Regulation (L; 3 SWS)
▪ Latest News in Molecular Microbiology (S; 1 SWS)
▪ Practical lab course ‘Molecular Microbiology’ (PL; 4 SWS)</td><td>45
15
60</td><td>240</td><td>360</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ TE: Written examination (WE60) on the contents of the lecture ‘Molecular Microbiology and Gene Regulation’
▪ C: regular participation in the practical lab course (CA*)
▪ C: Submission of a report on the practical lab course*
▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*</td></tr>
<tr><td>On offer</td><td colspan="4">Annually, in summer semester</td></tr>
<tr><td>Duration</td><td colspan="4">1 semester</td></tr>
<tr><td>Regular examination date</td><td colspan="4">2nd semester</td></tr>
</table>

Module can be selected for	M.Sc. Molecular Biology and Physiology
Recommended previous knowledge	In-depth knowledge of physiology and gene regulation in microorganisms, CM5

Advanced module 8 (AM8) 'Microbial Pathoproteomics'				
Responsible	Professors and staff of the Departments of Microbial Proteomics and Microbial Physiology and Molecular Biology at the Institute of Microbiology			
Language	English			
Module objectives	▪ Theoretical and practical knowledge of technologies in current proteomics research ▪ Knowledge of the application of proteomics in medical microbiology and in pathophysiological questions ▪ Practical experience in answering current questions in infection research			
Module contents	**Lecture 'Physiological Proteomics and Pathoproteomics of Microorganisms':** ▪ Milestones in microbial proteome research ▪ Current applications of proteomics in questions of microbial physiology and medical microbiology ▪ *In-vitro, in-vivo* and *in-situ* proteomics ▪ Metaproteomics applications in microbiology **Seminar 'Pathoproteomics and Pathophysiology':** ▪ Bacterial proteomes ▪ Comparative proteome analyses of pathogenic and apathogenic bacteria ▪ Bioinformatic tools for the analysis of proteomes and protein sequences ▪ Regulatory networks ▪ Structure and function predictions of bacterial proteins ▪ Scientific literature on new methods in protein analytics **Practical lab course 'Microbial Physiology/(Meta)-OMICs Studies':** ▪ Active participation in current research projects of the Institute of Microbiology			
Classes (in ECTS, SWS and h)	12 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Physiological Proteomics and Pathoproteomics of Microorganisms (L; 2 SWS)	30	240	360

	▪ Pathoproteomics and Pathophysiology (S; 1 SWS) ▪ Microbial Physiology/(Meta)-OMICs Studies (PL; 5 SWS)	15 75		
Assessment components	▪ TE: Written examination (WE60) on the contents of the lecture ▪ C: regular participation in the practical lab course (CA*) ▪ C: Presentation of a poster on the research findings from the practical lab course* ▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*			
On offer	Annually, in the 3rd and 4th semester			
Duration	2 semesters			
Regular examination date	3rd semester			
Module can be selected for	M.Sc. Molecular Biology and Physiology			
Recommended previous knowledge	Knowledge of microbial physiology and techniques used in modern proteomics, CM3, CM5			

Advanced module 9 (AM9) 'Functional Genomics'	
Responsible	Professors and staff of the Department of Functional Genomics (Interfaculty Institute of Genetics and Functional Genomics)
Language	English
Module objectives	▪ Imparting in-depth knowledge of functional genomics ▪ Teaching skills for planning and conducting experiments in the field of functional genomics ▪ Introduction to the evaluation of complex data
Module contents	**Lecture 'Application of Functional Genomics Techniques':** ▪ Functional genomics in biology and medicine ▪ Application-oriented presentation of genomics methods ▪ Presentation of the potential and limitations of functional genomics using examples from basic research, infection biology, tumour biology and cardiovascular medicine ▪ Introduction to systems biology research approaches including modelling ▪ Functional genomics and personalisation concepts ▪ Ethical aspects of functional genomics

<table>
<tr><td></td><td colspan="4">Lecture ‘Molecular Human Genetics’:
▪ Modern approaches to elucidating the molecular basis of hereditary diseases
▪ Next-generation sequencing methods and applications
▪ Handling molecular genetic data
▪ Categories of genetic variants and genome-wide association studies
▪ Genome structure

Lecture ‘Model Organisms and Methods of Functional Genomics’:
▪ Detailed presentation of the methods: genome editing, transcriptomics, proteomics, immunoproteomics, analysis of protein complexes, single cell analysis, biomarker screening
▪ Presentation of experimental concepts for the analysis of gene functions
▪ Use of model organisms to elucidate physiological and pathophysiological processes
▪ Research approaches in synthetic biology

Seminar ‘New Aspects in the Field of Functional Genomics’:
▪ Consolidation of the knowledge acquired in the lecture
▪ Study of selected current scientific literature on the subject area
▪ Independent presentation and discussion of current research results

Practical lab course ‘Functional Genomics’:
▪ Teaching how to plan and carry out laboratory experiments
▪ NGS-based analyses
▪ Digital PCR
▪ RT-PCR and northern hybridisation-based expression analyses
▪ Mass spectrometry-based proteome analyses
▪ Method-specific bioinformatic analysis</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Application of Functional Genomics (L; 2 SWS)
▪ Molecular Human Genetics (L; 1 SWS)
▪ Model Organisms and Methods of Functional Genomics (L; 1 SWS)
▪ New Aspects in the Field of Functional Genomics (S; 1 SWS)</td><td>30
15
15
15</td><td>225</td><td>360</td></tr>
</table>

	▪ Practical lab course 'Functional Genome Analysis' (PL; 4 SWS)	60		
Assessment components	▪ TE: Written examination (WE60) on the contents of the three lectures ▪ C: regular participation in the practical lab course (CA*) ▪ C: Submission of a report on the practical lab course* ▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*			
On offer	Annually, in summer semester			
Duration	1 semester			
Regular examination date	2nd semester			
Recommended previous knowledge	Knowledge of biochemistry, genetics and functional genomics, CM3, CM5			

Advanced module 10 (AM10) 'Biotechnology and Biophysics'	
Responsible	Professors and staff of the Departments of Biotechnology and Enzyme Catalysis, Synthetic and Structural Biochemistry, Biophysical Chemistry at the Institute of Biochemistry, Cellular Biophysics at the Institute of Physics, MNF
Language	English
Module objectives	▪ Basic knowledge of biotechnology; basic methods of protein production, isolation and purification ▪ Basic biophysical knowledge of infection biology ▪ Understanding of basic biophysical processes ▪ Understanding of required biophysical methods
Module contents	**Lecture Part I 'Selected Chapters on Fundamentals of Biotechnology and Protein Purification':** ▪ Reactor and fermenter types ▪ Carrying out fermentations ▪ Products of primary and secondary metabolism ▪ Introduction to protein purification ▪ Analytical methods (protein purity, content, activity) ▪ Isolation of proteins ▪ Chromatographic methods **Lecture part II 'Selected Chapters on Structure-Function Studies of Proteins in Infection and Inflammation':** ▪ Proteins: functions and folding ▪ Principles of the structural elucidation of proteins ▪ Structural elucidation in infection biology and immunology

<table>
<tr><td></td><td colspan="4">▪ Microscale thermophoresis (MST) and fluorescence to analyse the interaction of biomolecules
▪ Isothermal titration calorimetry

Lecture Part III ‘Biophysical Fundamentals of Infection Biology’:
▪ Protein-protein interactions including molecular motors
▪ Protein-sugar interactions
▪ Lipid-protein interactions
▪ Bacteria-cell interactions
▪ Autoimmune diseases and immunogenicity
▪ Formation of bacterial biofilms
▪ Transport phenomena, osmosis, viscosity, rheology, permeability
▪ Atomic force microscopy
▪ Real-time deformability cytometry (RT-DC)
▪ Single molecule process
▪ Super-resolution microscopy
▪ Fluorescence microscopy
▪ Circular dichroism spectroscopy
▪ Calorimetry

Seminar ‘Structure Elucidation and Biophysics in Infection Biology’:
▪ Literature research on current issues in the molecular and biophysical aspects of infection biology

Practical lab course ‘Structure Elucidation and Biophysics in Infection Biology’:
▪ Active participation in current research projects at the Institute of Biochemistry or Institute of Physics</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>12 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Lectures I-III (L; 2 SWS)
▪ Literature seminar ‘Structure Elucidation and Biophysics in Infection Biology’ (S; 1 SWS)
▪ Practical lab course ‘Structural Elucidation in Infection Biology’ (PL; 5 SWS)</td><td>30
15
75</td><td>240</td><td>360</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ TE: Written examination (KE60) on the contents of the lectures ‘Selected Chapters on Fundamentals of Biotechnology and Protein Purification’ and ‘Selected Chapters on Structure-Function Studies of Proteins in Infection and Inflammation’ as well as ‘Biophysical Fundamentals of Infection Biology’
▪ C: regular participation in the practical lab course (CA*)</td></tr>
</table>

	▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations* (according to the announcement at the beginning of the course) ▪ C: Submission of a report on the practical lab course*
On offer	Annually, in winter semester
Duration	1 semester
Regular examination date	3rd semester
Recommended previous knowledge	Basic knowledge of biochemistry and biophysics, CM5

Advanced module 11 (AM11) 'Metabolomics in Infection Research'	
Responsible	Professors and staff of the research group Metabolic Biochemistry and Metabolomics, Institute of Biochemistry
Language	English
Module objectives	▪ Imparting in-depth knowledge of metabolomics methods: Bioanalytical procedures and strategies as well as methods for sample generation or processing; use of HPLC-MS, GC-MS and NMR methods for the analysis of the metabolism of organisms ▪ Evaluation strategies in metabolomics using selected examples ▪ Knowledge of methods and strategies for the application of bioanalytical procedures of metabolic biochemistry with a focus on their application in infection research ▪ Deepened understanding of the integration of metabolome data into the systems biology context and the significance for the elucidation of the flow of substances in organisms ▪ Mastering basic methods of structural elucidation of natural products using NMR spectroscopy, HPLC-MS and GC-MS ▪ In-depth understanding of the primary and secondary metabolic biochemistry of prokaryotic and eukaryotic organisms ▪ Acquisition of knowledge of current developments in metabolic biochemistry in the seminar based on current fields of research in metabolomics (methods, strategies and applications) and current fields of research in the chemistry and biochemistry of primary and secondary natural products (biosyntheses, structure elucidation)
Module contents	**Lecture 'Metabolomics in Infection Research':** ▪ Introduction to the methods of investigating metabolic biochemical processes in prokrayotic and eukaryotic

<table>
<tr><td></td><td colspan="4">organisms using bioanalytical methods of metabolome research
▪ Imparting knowledge in metabolomics and introduction to other OMICs techniques with a focus on infection research
▪ Introduction to the methods of analysis and evaluation of complex OMICs data sets using mathematical methods
▪ Introduction to the analysis of metabolic fluxes and methods for elucidating the biosynthesis of primary and secondary natural products

Seminar ‘Recent Advances in Metabolomics in Infection and Immunology’:
▪ Imparting knowledge on current aspects of the biochemistry of primary and secondary natural substances
▪ Imparting knowledge of current developments in the analysis of the biochemical significance of primary and secondary natural products as well as new developments in the analysis of metabolic pathways using isotopologue analysis and fluxomics methods related to infection research
▪ In-depth discussion of current aspects of metabolic biochemistry and metabolomics in the field of infection research and immunology within a literature seminar</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>6 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Metabolomics in Infection Research (L; 2 SWS)
▪ Recent Advances in Metabolomics in Infection and Immunology (S; 2 SWS)</td><td>30

30</td><td>120</td><td>180</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ TE: Written examination (WE60) on the contents of the lecture
▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*</td></tr>
<tr><td>On offer</td><td colspan="4">Annually, in summer semester</td></tr>
<tr><td>Duration</td><td colspan="4">1 semester</td></tr>
<tr><td>Regular examination date</td><td colspan="4">2nd semester</td></tr>
<tr><td>Recommended previous knowledge</td><td colspan="4">In-depth knowledge of biochemistry
Attendance of the module ‘Introduction to OMICs Technologies’ CM3, CM5</td></tr>
</table>

Advanced module 12 (AM12) 'Microbiome in the One Health Context'	
Responsible	Professors and staff of the Institute of Microbiology, the Friedrich Loeffler Institute for Medical Microbiology and the Interfaculty Institute for Genetics and Functional Genomics
Language	English
Module objectives	▪ Conveying in-depth theoretical knowledge in the area of environmental microbiology and microbiome research ▪ In-depth knowledge of environmentally relevant groups of microorganisms, their distribution, significance and taxonomy ▪ In-depth knowledge of the human microbiome with its different locations ▪ Knowledge of the importance of the human microbiome for health and disease ▪ Knowledge of methods of qualitative and quantitative recording of microorganisms, as well as selected methods of microbiome research ▪ Ability to test scientific hypotheses; ability to independently design and conduct experiments
Module contents	**Lecture 'Selected Aspects of Microbiome Research':** ▪ Current issues in microbiome research ▪ Methods of microbiome research ▪ Functional and taxonomic marker genes ▪ Metagenomic and metatranscriptomic techniques ▪ Holobiont concept and evolutionary aspects ▪ Animal-associated microbiomes: identity and function ▪ The human microbiome: occurrence, composition and importance **Lecture 'Taxonomy, Phylogeny and Diversity of Microorganisms':** ▪ Classification schemes for prokaryotes ▪ Classical, chemical and molecular biological identification methods ▪ Phylogeny and diversity of bacteria and archaea ▪ Phylogeny and diversity of microbial eukaryotes ▪ Taxonomic and functional diversity **Seminar 'Advances and Methods in Microbiome Research':** ▪ Independent development and presentation of selected topics in microbiome research ▪ Study and evaluation of original English-language papers and further literature **Practical lab course 'Microbiome Research':**

	▪ Ability to test scientific hypotheses ▪ Experimental design; conception and independent implementation of a scientific experiment ▪ Getting to know special working and measuring techniques, work on high-performance equipment ▪ Bioinformatics of microbiome analyses			
Classes (in ECTS, SWS and h)	12 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Practical lab course 'Microbiome Research' (PL; 4 SWS) ▪ Selected Aspects of Microbiome Research (L; 2 SWS) ▪ Taxonomy, Phylogeny and Diversity of Microorganisms (L; 1 SWS) ▪ Advances and Methods in Microbiome Research (S; 1 SWS)	60 30 15 15	240	360
Assessment components	▪ TE: Written examination (WE60) on the contents of the lectures 'Selected Aspects of Microbiome Research' and 'Taxonomy, Phylogeny and Diversity of Microorganisms' ▪ C: regular participation in the practical lab course (CA*) ▪ C: Submission of a report on the practical lab course* ▪ C: Presentation* 20M on a scientific publication as part of the seminar and scientific discussion in the seminar presentations*			
On offer	Annually, beginning in winter semester			
Duration	2 semesters Lectures in winter semester (1st semester), practical lab course in summer semester (2nd semester).			
Regular examination date	Written examination in 1st semester (winter semester), completion of module in 2nd semester (summer semester)			
Recommended previous knowledge	Basic knowledge of microbiology and genomics, CM3, CM5			

Advanced module 13 (AM13) 'Applied Bioinformatics'	
Responsible	Professors and staff of the Institute of Bioinformatics at UMG and the Bioinformatics Working Group of the Institute of Mathematics and Computer Science
Language	English
Module objectives	▪ Knowledge for independently solving bioinformatics problems ▪ Understanding for working with web-based tools and databases

<table>
<tr><td></td><td colspan="4">▪ Deepening of medical and bioinformatics knowledge using applied examples</td></tr>
<tr><td>Module contents</td><td colspan="4">Lecture ‘Applied Medical Bioinformatics’:
▪ Introduction to bioinformatics tools and databases
▪ Alignments (multiple, BLAST)
▪ Motif searches and domain searches
▪ Functional annotation and metabolic pathways
▪ Interaction network analyses
▪ Ortholog searches and phylogenetic analyses
▪ Structure predictions for proteins and RNA

Exercises ‘Applied Medical Bioinformatics’:
▪ Using biological databases
▪ Structure prediction, domain prediction
▪ Functional annotation, regulatory interaction networks
▪ Ortholog search
▪ Co-expression analyses
▪ Processing of individual proteins and their full analysis based on examples

Exercises ‘Bioinformatics Programming’:
▪ Implementation of solutions to bioinformatics problems in Python
▪ Use of command line tools
▪ Biopython
▪ Pipeline creation</td></tr>
<tr><td rowspan="2">Classes
(in ECTS, SWS and h)</td><td>6 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Lecture ‘Applied Medical Bioinformatics’ (L; 1 SWS)
▪ Exercises ‘Applied Medical Bioinformatics’ (EX; 2 SWS)
▪ Exercises ‘Bioinformatics Programming’ (EX; 1 SWS)</td><td>15
30
15</td><td>120</td><td>180</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ C: 4 tests EX+L ‘Applied Medical Bioinformatics’
▪ C: 2 tests EX ‘Bioinformatics Programming’</td></tr>
<tr><td>On offer</td><td colspan="4">Annually, in summer semester</td></tr>
<tr><td>Duration</td><td colspan="4">1 semester</td></tr>
<tr><td>Regular examination date</td><td colspan="4">2nd semester</td></tr>
<tr><td>Recommended previous knowledge</td><td colspan="4">Applied Data Science CM4, CM5</td></tr>
</table>

Module ‘Research Practical’				
Responsible	Chairperson of the Examination Board			
Module objectives	Independent familiarisation with a specialised topic, independent execution of advanced experiments and evaluation/interpretation of the results obtained			
Module contents	Independent work on an experimental topic from ▪ Molecular Infection Biology ▪ Host Genetics in Infectious Diseases ▪ Virology and Cell Biology ▪ Antimicrobial Resistance in the One Health Context ▪ Infectious Immunology ▪ Clinical Module ▪ Pathophysiology & Molecular Adaptation of Microorganisms ▪ Microbial Pathoproteomics ▪ Functional Genomics ▪ Biotechnology & Biophysics ▪ Metabolomics ▪ Microbiome Research ▪ Applied Bioinformatics			
Classes (in ECTS and SWS)	8 ECTS are to be acquired:	Contact time	Self-study	Total workload
	▪ Research practical (experimental tasks within a research group on one of the topic areas named above, 4 weeks)	approx. 200	approx. 40	240
Assessment components	▪ Report (8-10 pages) on the investigated topic			
On offer	Permanently			
Duration	4 weeks			
Regular examination date	3rd semester			
Recommended previous knowledge	In-depth knowledge of the topic to be investigated			
Requirements	Completion of at least one advanced module			

Module ‘Work Placement’	
Responsible	Chairperson of the Examination Board
Module objectives	▪ The work placement can be completed in companies, enterprises, public authorities or other suitable scientific institutions(Appendix 1)

<table>
<tr><td></td><td colspan="4">▪ Insights into possible occupational activity and requirement profiles of an M.Sc. in Infection Biology and Immunology
▪ Independent work on tasks that have been transferred by the supervising institution
▪ Insights into organisational, social and professional structures of the supervising institution</td></tr>
<tr><td>Module contents</td><td colspan="4">The following aspects can be part of a work placement:
▪ Effective planning of workflows
▪ Collaboration on work processes and fields of activity of the supervising institution
▪ Monitoring and sales of biological, biomedical or pharmacological products
▪ Studies of biological objects under natural conditions
▪ Preparation and presentation of results obtained

Participation in a project manager course according to § 15 GenTSV (Genetic Engineering Safety Ordinance) is recognised. The following contents should be covered:
▪ Introduction to genetic engineering law
▪ Other legal provisions (e.g. BiostoffVO (Biological Agents Ordinance), IfSG (Protection against Infection Act))
▪ Risk assessment and potential hazards
▪ Sterilisation, disinfection, inactivation and transport of biological materials
▪ Working with transgenic plants and animals
▪ Environmental considerations in the release of transgenic organisms
▪ Stability of genetic traits
▪ Pathology and epidemiology of bacterial infections</td></tr>
<tr><td rowspan="2">Classes
(in ECTS and SWS)</td><td>10 ECTS are to be acquired:</td><td>Contact time</td><td>Self-study</td><td>Total workload</td></tr>
<tr><td>▪ Completion of independent work tasks at an external institution and related follow-up work (8 weeks)</td><td>approx. 250</td><td>approx. 50</td><td>300</td></tr>
<tr><td>Assessment components</td><td colspan="4">▪ Written confirmation of the performed tasks from the supervising institution and 4-page report*</td></tr>
<tr><td>On offer</td><td colspan="4">Permanently</td></tr>
<tr><td>Duration</td><td colspan="4">8 weeks (non-teaching periods); 2nd or 3rd semesters</td></tr>
<tr><td>Recommended previous knowledge</td><td colspan="4">Completion of at least one advanced module</td></tr>
</table>

Module 'Master's Dissertation'		
Responsible	Chairperson of the Examination Board	
Module objectives	▪ The master's dissertation is written on a topic belonging to one of the chosen advanced modules. The student can choose a supervisor from all professorial staff who have teaching responsibilities in this area. ▪ Acquisition of the ability to work independently on a given biological task of limited scope in the chosen project area. ▪ Acquisition of the ability to present the results obtained in the form of a scientific piece of writing.	
Module contents	▪ Preparation of a work plan ▪ Review of literature ▪ Development of a methodological strategy to solve the assigned task ▪ Carrying out the task and applying suitable evaluation methods ▪ Discussing the findings and placing them within the theoretical context ▪ Writing up the master's dissertation ▪ Oral presentation and discussion of the master's dissertation (defence)	
Classes (in ECTS and SWS)	30 ECTS are to be acquired:	Overall workload
	▪ Experimental tasks within a research group with a total duration of 6 months	900
Assessment components	▪ Written master's dissertation and defence	
On offer	Permanently	
Duration	1 semester	
Regular examination date	4th semester	
Admission requirements	At least 48 ECTS from the core and advanced modules as well as successful completion of the research practical	
Recommended previous knowledge	Completion of the core modules and the advanced modules on the selected topic	