**Modules for Pharmazie**

Date 29/04/25

# Pflichtmodule

## PHA.03532.02 - Drug target identification and validation

| PHA.03532.02 | 10 CP |
|---|---|
| **Module label** | Drug target identification and validation |
| **Module code** | PHA.03532.02 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Prof. Dr. W. Sippl |
| **Prerequisites** | |
| **Skills to be acquired in this module** | • Basic understanding of drug substances and drug targets • Knowledge of methods and illustrative examples of drug target identification and valida-tion • Basic understanding of the connection between molecular and clinical effects of drug substances • Knowledge of bioanalytical tools for protein separation and ~identification • Ability to judge the quality of results, i.e., protein identification, protein quantitation • Ability to set up a proteomics workflow in industry • Application of proteomics methods to diseases • Knowledge of edible vaccine concepts • Knowledge of fusion protein strategies • Understanding of differences between stable and transient expression systems • Knowledge of the basic concepts of Computational Biology and Bioinformatics • A first and transparent introduction in comparative modeling and molecular dynamics simulations • Concepts of analyzing proteins/drug targets in 3D • Principles of modeling biological data |
| **Module contents** | Course B.1: General aspects of drug target identification and validation • Definition and characteristics of drug substances • Definition and characteristics of molecular drug targets • Interaction of drug substances and drug targets • Propagation of molecular drug effects • Methods and techniques for the identification and validation of drug targets • Correlation and causality of molecular and clinical drug effects<br>Course B.2: Proteomics • Methods for separating complex protein mixtures (2-DE, LC) • Protein mass spectrometry (ionization methods; mass analyzers) • Protein sequencing • Quantitative proteomics (ICAT, iTRAQ) • Analysis of post-translational modifications (glycosylation, phosphorylation) • Protein-protein interactions • In-vivo proteomics • Proteome analysis for investigation of diseases • Automation of the proteomics workflow<br>Course B.3: Molecular F(Ph)arming - Basics, Principles and Examples • General overview about expression of human proteins in transgenic organisms including microorganisms and mammalian cells. • Basics of intracellular sorting with special focus to plant cells. • N-glycosylation especially according the differences between plants and mammals. • Plantibody concept • Fusion protein strategies (expression enhancement, stability enhancement • Vaccines from plants including edible vaccine concepts. • Therapeutic antibodies from plants, different recombinant antibody formats. • Plant-based production of therapeutic proteins as human serum albumins and insulin as well as silk proteins for nanomedicine<br>4. Course B.4: Protein modeling and simulation • Introduction to Bioinformatics and comparative/homology modeling • Introduction in sequence alignment techniques • Analyzing protein structures • Commonly used force fields for protein simulations • Introduction to Molecular Dynamics • Introduction to docking simulations |
| **Forms of instruction** | Lecture (2 SWS)<br>Lecture (2 SWS)<br>Seminar (2 SWS)<br>Lecture (1 SWS)<br>Seminar (1 SWS)<br>Lecture (1 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |

PHA.03532.02 10 CP

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|---|---|
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 10 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %; Course 6: %; Course 7: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |
| **Course 6** | | |
| **Course 7** | | |
| **Final exam of module** | | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Proteomics | 2 | | | | | 0 |
| **Course 2** | Lecture | Molecular F(Ph)arming - Basics, Principles and Examples | 2 | | | | | 0 |
| **Course 3** | Seminar | Protein modeling and simulation | 2 | | | | | 0 |
| **Course 4** | Lecture | General aspects of drug target identification and validation | 1 | | | | | 0 |
| **Course 5** | Seminar | General aspects of drug target identification and validation | 1 | | | | | 0 |
| **Course 6** | Lecture | Protein modeling and simulation | 1 | | | | | 0 |
| **Course 7** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 300 | | 300 |
| **Total module workload** | | | | | | | | 300 |

## PHA.03541.03 - Biopharmaceuticals in regenerative medicine

| PHA.03541.03 | 10 CP |
|---|---|
| **Module label** | Biopharmaceuticals in regenerative medicine |
| **Module code** | PHA.03541.03 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Prof. Dr. T. Groth |
| **Prerequisites** | |
| **Skills to be acquired in this module** | • Knowledge on the application of Biopharmaceuticals in `Regenerative Medicine`, Clarification of terms and definitions • Overview about biopharmaceuticals interesting for Regenerative Medicine • General techniques to embed or attach biopharmaceuticals to carriers or their single application • Preparation of carriers and scaffolds • Effects of biopharmaceuticals on mammalian cells and whole organism • Adverse reactions of organism on carriers and biopharmaceuticals • Selection and manipulation of cells • Selected examples of biopharmaceutical application in regenerative medicine |
| **Module contents** | 1. Basic concepts of biopharmaceuticals application in regenerative medicine • Introduction to regenerative medicine • Biopharmaceuticals in regenerative medicine • Target validation and delivery of biopharmaceuticals • Cell adhesion, migration, and growth • Regulation of signal transduction, gene expression, differentiation • Blood compatibility of carriers and biopharmaceuticals • Immunocompatibility of carriers and biopharmaceuticals • Histocompatibility of carriers and biopharmaceuticals<br>2. Application of biopharmaceuticals in regenerative medicine • Preparation of carriers and scaffolds • Techniques to functionalize carriers and scaffolds • Concept of biomimetics • Techniques for immobilization and delivery of biopharmaceuticals • Cells in regenerative medicine • Adult and embryonic stem cells • Examples of biopharmaceutical application for regeneration of different tissues<br>3. Application of biopharmaceuticals for regeneration of bone • Preparation of model scaffold • Embedding of adhesive proteins and growth factors • Studies of mesenchymal stem cell adhesion and differentiation |
| **Forms of instruction** | Lecture (4 SWS)<br>Seminar (1 SWS)<br>Practical training (2 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 10 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Final exam of module** | Protocol on lab course | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Biopharmaceuti | 4 | | | | | 0 |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| | | cals in regenerative medicine | | | | | | |
| **Course 2** | Seminar | Biopharmaceuticals in regenerative medicine | 1 | | | | | 0 |
| **Course 3** | Practical training | Biopharmaceuticals in regenerative medicine | 2 | | | | | 0 |
| **Course 4** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 300 | | 300 |
| **Total module workload** | | | | | | | | 300 |

## PHA.03531.03 - Introduction to Pharmaceutical Biotechnology

| PHA.03531.03 | 5 CP |
|---|---|
| **Module label** | Introduction to Pharmaceutical Biotechnology |
| **Module code** | PHA.03531.03 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Prof. Dr. M. Pietzsch |
| **Prerequisites** | |
| **Skills to be acquired in this module** | Knowledge of the basic concepts and technologies of Pharmaceutical Biotechnology: Terminology & Definitions<br>Overview on industrial development and production processes<br>Knowledge of product classes<br>Insight to interdisciplinary cooperation in biopharmaceutical drug development and production<br>Organizational structures and industries<br>Interrelation of biotechnology & medicine<br>Practical skills in biochemical methods<br>Practical skills in chemical calculations |
| **Module contents** | A.1 Course A.1: Introduction to Pharmaceutical Biotechnology • General introduction and history of Pharmaceutical Biotechnology (PhBT) • Products of Pharmaceutical Biotechnology • Drug target identification, and validation • Selection and construction of production strains • Production aspects: Up- and Downstream Processing • Introduction to formulation • Analytical aspects • Clinical aspects • Regulatory aspects<br>A.2 Course A.2: Basic lab course on biochemical methods • Chemical calculations (stoichiometry) • Weighing, Pipetting • Spectrophotometry • Centrifugation • Dialysis • Measurement of pH, preparation of buffer solutions, ionic strength. • Protein assay using BRADFORD and BCA-methods • Determination of enzyme activity, continuous and end point methods |
| **Forms of instruction** | Lecture (2 SWS)<br>Practical training (2 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 5 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Final exam of module** | Examination on lab course contents, Protocol on lab course | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Introduction to Pharmaceutical Biotechnology | 2 | | | | | 0 |
| **Course 2** | Practical training | Basic lab course on | 2 | | | | | 0 |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| | | biochemical methods | | | | | | |
| **Course 3** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 150 | | 150 |
| **Total module workload** | | | | | | | | 150 |

## PHA.03535.02 - Optimization of bioprocesses

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|---|---|
| PHA.03535.02 | 5 CP |
| **Module label** | Optimization of bioprocesses |
| **Module code** | PHA.03535.02 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Dr. N. Volk |
| **Prerequisites** | Modul D: Introduction to Bioprocess Technology (Upstream Processing) |
| **Skills to be acquired in this module** | • Knowledge of mathematical modeling to optimization of bioprocesses • Foundations in the use of simulations languages • Using tools to identification, simulation and optimization • Application of models to optimization of bioprocesses • Knowledge of planning and preparation of bioreactor cultivations • Laboratory scale development of strategies for optimal bioprocessing technologies • Experience in the use of bioprocess cultivation techniques • Practical experience in the preparation and implementation of fermentations • Analyze and validate of results of fermentations |
| **Module contents** | Course E.1: Modeling and simulation • Principles of bioprocess modeling and optimization • Modeling concepts for biological systems and bioreactors • Dynamic modeling of bioreactors • Introduction in simulation language (MATLAB, Copasi, Celldesigner) • Case studies to simulation • Optimization of bioprocesses • Case studies to optimization<br>Course E.2: Control of bioreactor cultivations • Planning of a bioreactor cultivation process • Mathematical simulation of the process • Preparation of the bioprocess techniques and analytics • Experimental realization of the cultivation process • Analyze and validate the results • Identification of a model from the results • Describe and analyze the process |
| **Forms of instruction** | Practical training (2 SWS)<br>Lecture (1 SWS)<br>Seminar (1 SWS)<br>Seminar (1 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Sommersemester |
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 5 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |
| **Final exam of module** | 1 attestation, 1 protocol, 5 exercises | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Practical training | Control of bioreactor cultivations | 2 | | | | | 0 |
| **Course 2** | Lecture | Modeling and | 1 | | | | | 0 |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| | | Simulation | | | | | | |
| **Course 3** | Seminar | Modeling and Simulation | 1 | | | | | 0 |
| **Course 4** | Seminar | Control of bioreactor cultivations | 1 | | | | | 0 |
| **Course 5** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 150 | | 150 |
| **Total module workload** | | | | | | | | 150 |

## PHA.03542.02 - Project work

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| PHA.03542.02 | | 5 CP |
| **Module label** | Project work | |
| **Module code** | PHA.03542.02 | |
| **Semester of first implementation** | | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule | |
| **Responsible person for this module** | | |
| **Further responsible persons** | Prof. Dr. M. Pietzsch | |
| **Prerequisites** | Module D: Introduction to bioprocess technology; Module E: Optimization of bioprocesses; Module G: Purification of products from pharmaceutical biotechnology | |
| **Skills to be acquired in this module** | • first independent research experience for the students • literature studies and experimental work • writing of reports • defending results | |
| **Module contents** | • participation in a research group • introduction to independent research of the students • combining literature and experimental research • independent preparation of the research report • oral presentation of the results using Power Point; discussion of the results | |
| **Forms of instruction** | Course (4 SWS)<br>Course | |
| **Languages of instruction** | German, English | |
| **Duration (semesters)** | 1 Semester Semester | |
| **Module frequency** | jedes Wintersemester | |
| **Module capacity** | unlimited | |
| **Time of examination** | | |
| **Credit points** | 5 CP | |
| **Share on module final degree** | Course 1: %; Course 2: %. | |
| **Share of module grade on the course of study's final grade** | 1 | |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Final exam of module** | | Lehrforschungsbericht, Mündliche Präsentation und Verteidigung |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Course | Project work | 4 | | | | | 0 |
| **Course 2** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 150 | | 150 |
| **Total module workload** | | | | | | | | 150 |

## PHA.03540.03 - Biopharmaceuticals

| PHA.03540.03 | 5 CP |
|---|---|
| **Module label** | Biopharmaceuticals |
| **Module code** | PHA.03540.03 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Prof. Dr. B. Dräger |
| **Prerequisites** | Module A: Optimization of bioprocesses; Module E: Introduction to pharmaceutical biotechnology |
| **Skills to be acquired in this module** | • Knowledge of the basic concepts of immune response • Overview on immunotherapeutics, vaccines, antibodies, fusion proteins, future develop-ments • Overview of the different types of monoclonal antibodies (mAbs) • Knowledge of the targets for mAbs • Knowledge of the PK and PD characteristics of mAbs • Insight into mAbs under clinical development • Insight into the currently approved mAbs • Understanding of antibody production: polyclonal antibodies from mice, monoclonal an-tibodies from hybridoma cells, recombinant antibodies from bacteria • Understanding of antibody action: specificity, affinity, avidity • Understanding the background and basics of different immunological tests: ELISA, Western blot and hemagglutination test, practical experience. • Understanding the production (phages, bacteria) and physical (Western blot) and func-tional (ELISA) characterization of different formats of recombinant antibodies: nanobod-ies, scFv. • Practical experience in the purification of antibodies from sera by affinity chromatography • Diseases relevant for DNA therapy • Functional aspects of therapeutic DNA • Delivery systems for DNA • Current therapy strategies |
| **Module contents** | Course K.1: Vaccines, Immunology • Basic immunology: innate and specific immune response • Basics of immune cell differentiation, B- and T-lymphocytes • Basics of immune system receptors and signaling • Basics of tumor immunology • Basics of allergy sand autoimmune disease • Vaccines in use and in development • Antibodies for therapy and diagnosis<br>Course K.2: Clinical development of monoclonal antibodies • Basics of immunology • Technical and methodical basics of production/selection of monoclonal antibodies by classical methods and advanced modern technologies • The selection of monoclonal recombinant antibodies of different formats by Phage Dis-play, Screening • Production of monoclonal antibodies in CHO cells including optimization of cell lines, cul-tivation, media, scale up as well as purification strategies and methods. • Plant-based antibody production is generally explained with a specific focus to expres-sion enhancement, purification tags and glycol-engineering. • Mechanisms of action of therapeutic antibodies • Antibody optimization wrt pharmacokinetical half-life extension, ADCC and CDC • Development of therapeutic anti-tumour antibodies • Approval and necessary tests to perform phase I, II and II trials. • Bleeding of immunized mice, production of sera, characterization by ELISA and Western blot • Lab course: Observation of hybridoma cultures, harvest of supernantants, functional characterization by ELISA and Western blot • Production of specific display phages, nanobodies and scFv in E. coli, physical • characterization by Western blot and functional characterization by competitive ELISA • Characterization of potentially neutralizing anti H5N1 antibodies in an hemagglutination test with plant-derived Virus-Like-Particles (VLPs)<br>Course K.3: DNA for gene therapy • DNA therapy: monogenic diseases, cancer • Therapeutic DNA: structure, preparation, quality control, biological requirements • Delivery systems: viral, liposomes, other - advantages/disadvantages • Experimental test systems, cell culture, animal model • Current therapy protocols |
| **Forms of instruction** | Lecture (2 SWS)<br>Lecture (1 SWS)<br>Lecture (1 SWS)<br>Course<br>Practical training (2 SWS) |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |

PHA.03540.03 5 CP

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|---|---|
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 5 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |
| **Final exam of module** | attestation on lab course contents, Protocol on lab course | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Vaccines, Immunology | 2 | | | | | 0 |
| **Course 2** | Lecture | Clinical development of monoclonal antibodies | 1 | | | | | 0 |
| **Course 3** | Lecture | DNA for gene therapy | 1 | | | | | 0 |
| **Course 4** | Course | Selbststudium | | | | | | 0 |
| **Course 5** | Practical training | Lab course on basics of immunological methods | 2 | | | | | 0 |
| **Workload by module** | | | | | | 150 | | 150 |
| **Total module workload** | | | | | | | | 150 |

## PHA.03537.03 - Purification of products of pharmaceutical biotechnology (Downstream Processing)

| PHA.03537.03 | 10 CP |
|---|---|
| **Module label** | Purification of products of pharmaceutical biotechnology (Downstream Processing) |
| **Module code** | PHA.03537.03 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Prof. Dr. M. Pietzsch |
| **Prerequisites** | Module C: Construction of production organisms; Module D: Introduction to bioprocess technology |
| **Skills to be acquired in this module** | • Knowledge of the basic concepts of downstream processing • Foundations of protein purification • Knowledge on equipment and design parameters • Knowledge of scale-up parameters • Challenges in prevention or elimination of contaminants • Knowledge on process integration: Strain development, up- and downstream processing • Bbasics of technical/industrial purification of proteins • Know how to plan and perform the purification of a target protein from biomass |
| **Module contents** | Course G.1: Introduction to Downstream Processing • Overview on potential contaminations of target products and strategies for their removal • Equipment: Design and operation • Cell disintegration • Solid-Fluid separations • Liquid-Liquid extraction • Precipitation and crystallization • Chromatographic separations • Special applications: Purification of membrane proteins, inclusion bodies, antibodies, vi-ruses, DNA, etc.<br>Course G.2: Practical course on Downstream Processing • Purity control by SDS-PAGE and determination of specific enzymatic activity • Cell disintegration • Solid / Liquid Separation • Protein precipitation • Preparative chromatography for the purification of proteins • Packing of chromatography columns • Generation of purification tables |
| **Forms of instruction** | Lecture (2 SWS)<br>Seminar (1 SWS)<br>Seminar (1 SWS)<br>Practical training (4 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Sommersemester |
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 10 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |
| **Final exam of module** | 1 attestation, 1 presentation, 1 protocol on lab course | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Introduction to | 2 | | | | | 0 |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| | | Downstream Processing | | | | | | |
| **Course 2** | Seminar | Introduction to Downstream Processing | 1 | | | | | 0 |
| **Course 3** | Seminar | Practical course on Downstream Processing | 1 | | | | | 0 |
| **Course 4** | Practical training | Practical course on Downstream Processing | 4 | | | | | 0 |
| **Course 5** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 300 | | 300 |
| **Total module workload** | | | | | | | | 300 |

## PHA.03536.02 - Legal and economical aspects of pharmaceutical biotechnology

| PHA.03536.02 | | | 5 CP |
|---|---|---|---|
| **Module label** | | Legal and economical aspects of pharmaceutical biotechnology | |
| **Module code** | | PHA.03536.02 | |
| **Semester of first implementation** | | | |
| **Module used in courses of study / semesters** | | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule | |
| **Responsible person for this module** | | | |
| **Further responsible persons** | | Prof. Dr. P. Imming | |
| **Prerequisites** | | | |
| **Skills to be acquired in this module** | | • Understanding of drug quality requirements, pre-requisites and activities • Basic knowledge of the European drug quality system • Connection of the European system with international regulations, differences and over-laps • Knowledge of basic concepts for GMP and on differences between European and US regulations • Knowledge of the basic concepts of a) Strategic & business planning (corporate, marketing, financial, R&D) b) value assessment of developmental projects and intellectual properties with simple standard methods (NPV, double-sided NPV, benchmarking etc) c) portfolio strategy d) structuring cooperation agreements e) patent assessment and trading intellectual properties (licensing) f) alliances and joint ventures • Drafting and evaluation of different forms of cooperation agreements • Calculating value of a particular product in development • Understanding and drafting a commercial term sheet for licensing of a particular product from a development to a distributor company • Drafting a business plan | |
| **Module contents** | | Course F.1: Drug quality control - European and international standards and regulations • Requirements for drugs: efficacy, safety, quality • Drug quality: definitions, legal requirements, standards, methods • Good Manufacturing Practices, emphasis on quality; CPMP and ICH guidelines on qual-ity • European, US, and other pharmacopoeiae of international importance<br>Course F.2: Good Manufacturing Practice - European and international regulations • European GMP regulations • Application of GMP guidelines for biotechnology • Aseptic processing • Qualification of materials and devices for pharmaceutical manufacturing • Process validation • GMP compliant documentation • Qualified persons in GMP manufacturing • Modern concepts for `Quality by Design` and Process Analytical Technology<br>Course F.3: Economical and marketing aspects, patents and licensing • Strategic planning • Business Plan • Value assessment • Important legal issues for structuring different cooperation agreements • Evaluation of Intellectual Properties • Trading with Intellectual Properties • Exercise Course based on a case study | |
| **Forms of instruction** | | Lecture (2 SWS)<br>Lecture (1 SWS)<br>Lecture (1 SWS)<br>Course | |
| **Languages of instruction** | | German, English | |
| **Duration (semesters)** | | 1 Semester Semester | |
| **Module frequency** | | jedes Sommersemester | |
| **Module capacity** | | unlimited | |
| **Time of examination** | | | |
| **Credit points** | | 5 CP | |
| **Share on module final degree** | | Course 1: %; Course 2: %; Course 3: %; Course 4: %. | |
| **Share of module grade on the course of study's final grade** | | 1 | |
| Examination | Exam prerequisites | | Type of examination |
| **Course 1** | | | |
| **Course 2** | | | |
| **Course 3** | | | |
| **Course 4** | | | |
| **Final exam of module** | | | Klausur |
| **Exam repetition information** | | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Economical and marketing aspects, patents and licensing | 2 | | | | | 0 |
| **Course 2** | Lecture | Drug quality control - European and international standards and regulations | 1 | | | | | 0 |
| **Course 3** | Lecture | Good manufacturing practice - European and international regulations | 1 | | | | | 0 |
| **Course 4** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 150 | | 150 |
| **Total module workload** | | | | | | | | 150 |

## PHA.03538.03 - Validation of Process and Product

| PHA.03538.03 | | 10 CP |
|---|---|---|
| **Module label** | Validation of Process and Product | |
| **Module code** | PHA.03538.03 | |
| **Semester of first implementation** | | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule | |
| **Responsible person for this module** | | |
| **Further responsible persons** | Dr. M. Niepel | |
| **Prerequisites** | Module B: Drug target identification and validation | |
| **Skills to be acquired in this module** | • Basics of chromatographic separation and identification of small molecules • Basics of GC-MS and HPLC-MS • Understanding the role of computing in knowledge discovery and apply bioinformatics tools in data processing, workflow automation, and structure determination. • Ability to critically analyze and evaluate different approaches to generating models and simulations from biological databases. • Knowledge of the basic concepts of chromatography and mass spectrometry • Ability to set up a proteomics workflow in industry • Ability to judge the quality of results, i.e. protein identifications | |
| **Module contents** | Course H.1: Detection of potential contaminations • Sample preparation from biological matrices • Plant product chromatography • How to quantify, if there is no (standard) compound • Distinction of similar compounds • Labeling and spiking of samples • Practical examples and problems<br>Course H.2: Structure analysis • Bioinformatics in large scale proteomics and lipidomics • Genome and proteome databases, annotations, and search engines • Preprocessing of mass spectra • Principles and algorithms for peptide and protein sequence analysis • Identification of PTMs: classic and blind mode • Determination of elemental compositions by mass spectrometry • Molecular profiling and imaging techniques, Ion Mobility Spectroscopy • Vibrational spectroscopy: FT-IR, NIR, Raman, and Terahertz spectroscopies • Multivariate analysis for qualitative (principal component analysis) and quantitative (partial least squares regression) analysis<br>Course H.3: Protein analysis by mass spectrometry • Methods for separating complex protein and peptide mixtures (gel electrophoresis, HPLC) • In-gel and in-solution proteolysis of proteins • Protein mass spectrometry (ionization methods ESI and MALDI; mass analyzers TOF, LIT, , Orbitrap, hybrid instruments) • Peptide sequencing by mass spectrometry (MS/MS) • Database searches (Mascot) • Scoring algorithms for protein identification • Automation of the proteomics workflow | |
| **Forms of instruction** | Lecture (2 SWS)<br>Seminar (1 SWS)<br>Lecture (2 SWS)<br>Practical training (1 SWS)<br>Practical training (2 SWS)<br>Course | |
| **Languages of instruction** | German, English | |
| **Duration (semesters)** | 1 Semester Semester | |
| **Module frequency** | jedes Sommersemester | |
| **Module capacity** | unlimited | |
| **Time of examination** | | |
| **Credit points** | 10 CP | |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %; Course 6: %. | |
| **Share of module grade on the course of study's final grade** | 1 | |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |

| Examination | | | Exam prerequisites | | | Type of examination | | |
|---|---|---|---|---|---|---|---|---|
| **Course 6** | | | | | | | | |
| **Final exam of module** | | | attestation on lab course contents - Course H.2: Structure analysis, attestation on lab course contents - Course H.3: Protein analysis by mass spectrometry, Protocol on lab course | | | Klausur | | |
| **Exam repetition information** | | | | | | | | |
| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
| **Course 1** | Lecture | Detection of potential contaminations | 2 | | | | | 0 |
| **Course 2** | Seminar | Detection of potential contaminations | 1 | | | | | 0 |
| **Course 3** | Lecture | Structure analysis | 2 | | | | | 0 |
| **Course 4** | Practical training | Structure analysis | 1 | | | | | 0 |
| **Course 5** | Practical training | Protein analysis by mass spectrometry | 2 | | | | | 0 |
| **Course 6** | Course | Private study | | | | | | 0 |
| **Workload by module** | | | | | | 300 | | 300 |
| **Total module workload** | | | | | | | | 300 |

## PHA.03539.02 - Technological and clinical aspects of biopharmaceuticals

| PHA.03539.02 | 10 CP |
|---|---|
| **Module label** | Technological and clinical aspects of biopharmaceuticals |
| **Module code** | PHA.03539.02 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Prof. Dr. M. Pietzsch |
| **Prerequisites** | Module D: Introduction to Bioprocess technology; Module H: Validation of process and product |
| **Skills to be acquired in this module** | • Knowledge of formulation principles for biotech products • Challenges of protein formulations • Knowledge of formulation processes and ingredients • Knowledge of drug delivery mechanisms and kinetics • Knowledge of parenteral controlled release formulations • Knowledge on posttranslational modifications of proteins in vivo • Rationale behind posttranslational modification of proteins • Know-how to synthetically modify proteins in vitro • Knowledge on the application of biocatalysts for the synthesis of drugs • Biosynthetic pathways of plant secondary metabolites • Regulatory mechanisms of metabolite production • Plant-derived pharmaceuticals • Strategies to produce metabolites in transgenic plants • Successful examples of pharmaceutical production in plants • Knowledge of the basic concepts of Pharmacokinetics • Overview on the pharmacokinetic models • Knowledge concerning the relevant pharmacokinetic parameters • Basics of the physiological background of the Pharmacokinetics • Application of the pharmacokinetic evaluation on selected drugs |
| **Module contents** | Course I.1: Drug delivery • Principles of protein formulation • Rational based formulation development / Formulation Screening • Stabilization principles for proteins • Controlled Release: Principles, Materials and Kinetics • In vitro - In vivo Correlation of Drug Release<br>Course I.2: Covalent modifications of proteins • Posttranslational modifications found in nature, e. g. glycosylation, farnesylation, phos-phorylation, protein-protein cross-linking, protein splicing, oxidation, etc. • Enzymes involved in posttranslational modification • Bio and chemo catalysis for the in vitro modification of proteins, e. g. PEGylation, transglutaminase, lysyl oxidase. • Application of biocatalysts in drug synthesis and enzyme technology, e. g. synthesis of semi-synthetic penicillin's, synthesis of optically pure D-amino acids, regiospecific hy-droxylation of steroids, etc.<br>Course I.3: Advanced course on plant cell technology • Induction and subcultivation of plant cell cultures • Induction and cultivation of organ cultures • Selection of cell strains by cell aggregat and protoplast cloning • Introduction of foreign genetic material into plant cells • Expression of foreign genetic material using plant cell and hairy root cultures • In vitro storage of plant cell culture and meristems by cryopreservation<br>Course I.4: Pharmacokinetics • General Introduction and history of Pharmacokinetics • Pharmacokinetic concepts and models • Pharmacokinetic characterization of drug using relevant parameters • Physiological and physicochemical background • Application of the pharmacokinetic analysis on drugs and formulations • Relevant routes of administration |
| **Forms of instruction** | Lecture (2 SWS)<br>Lecture (2 SWS)<br>Lecture (2 SWS)<br>Lecture (2 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 10 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |
| **Final exam of module** | 1 Protokoll | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Drug delivery | 2 | | | | | 0 |
| **Course 2** | Lecture | Covalent modification(s) of proteins | 2 | | | | | 0 |
| **Course 3** | Lecture | Advanced course on plant cell technology | 2 | | | | | 0 |
| **Course 4** | Lecture | Pharmacokinetics | 2 | | | | | 0 |
| **Course 5** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 300 | | 300 |
| **Total module workload** | | | | | | | | 300 |

## PHA.03534.02 - Introduction to Bioprocess technology (Upstream Processing)

| PHA.03534.02 | 5 CP |
|---|---|
| **Module label** | Introduction to Bioprocess technology (Upstream Processing) |
| **Module code** | PHA.03534.02 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | Dr. N. Volk |
| **Prerequisites** | |
| **Skills to be acquired in this module** | • Knowledge of the basic concept of bioprocess technology • Foundations of microbial growth and cultivation principles • Application of bioprocess engineering principles • knowledge of bioreactor operations and their industrial applications • Basics of technical/industrial fermentation processes |
| **Module contents** | • Basics of bioprocess technology • Microbial growth and cultivation principles • Reactor design and instrumentation • process control of bioreactors • balancing and design of bioreactors • Bioprocess scale-up • sterile technology • Application of fermentation processes • Bioprocess case studies |
| **Forms of instruction** | Lecture (3 SWS)<br>Seminar (1 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |
| **Module capacity** | unlimited |
| **Time of examination** | |
| **Credit points** | 5 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Final exam of module** | | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Bioprocess technology | 3 | | | | | 0 |
| **Course 2** | Seminar | Bioprocess technology | 1 | | | | | 0 |
| **Course 3** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 150 | | 150 |
| **Total module workload** | | | | | | | | 150 |

## PHA.03543.02 - Master thesis

| PHA.03543.02 | | | 30 CP |
|---|---|---|---|
| **Module label** | | | Master thesis |
| **Module code** | | | PHA.03543.02 |
| **Semester of first implementation** | | | |
| **Module used in courses of study / semesters** | | | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | | | |
| **Further responsible persons** | | | Prof. Dr. M. Pietzsch |
| **Prerequisites** | | | 90 credit points |
| **Skills to be acquired in this module** | | | • carrying out of independent research • literature studies and experimental work • writing of the thesis • defense of the thesis |
| **Module contents** | | | • thesis related to the development, analytics, production, isolation, formulation, or appli-cation of biopharmaceuticals • carrying out literature research • collecting experimental data and doing of data evaluation • oral presentation of the final thesis including defense |
| **Form of instruction** | | | Independent supervised work (30 SWS) |
| **Languages of instruction** | | | German, English |
| **Duration (semesters)** | | | 1 Semester Semester |
| **Module frequency** | | | jedes Sommersemester |
| **Module capacity** | | | unlimited |
| **Time of examination** | | | |
| **Credit points** | | | 30 CP |
| **Share on module final degree** | | | Course 1: %. |
| **Share of module grade on the course of study's final grade** | | | 1 |
| Examination | Exam prerequisites | | Type of examination |
| **Course 1** | | | |
| **Final exam of module** | | | written Master thesis, oral presentation and examination / |
| **Exam repetition information** | | | |
| **Form of instruction** | Independent supervised work | | |
| **Course name** | MA-Arbeit | | |
| **SWS** | 30 | | |
| **Workload of compulsory attendance** | | | |
| **Workload of preparation / homework etc** | | | |
| **Workload of independent learning** | | | |
| **Workload (examination and preparation)** | | | |
| **Workload total** | 0 | | |
| **Workload self-arranged work (module-oriented** | 900 | | |
| **Total module workload** | 900 | | |
| **Type of examination** | | | |
| **Frequency** | Summer semester | | |
| **Capacity** | unlimited | | |

## PHA.03533.03 - Construction of production organisms: Hosts and vectors

| PHA.03533.03 | 10 CP |
|---|---|
| **Module label** | Construction of production organisms: Hosts and vectors |
| **Module code** | PHA.03533.03 |
| **Semester of first implementation** | |
| **Module used in courses of study / semesters** | • Pharmaceutical Biotechnology (MA120 LP) (Master) > Pharmazie Pharmaceut.Biotech.MA120, Version of accreditation (WS 2008/09 - WS 2015/16) > Pflichtmodule |
| **Responsible person for this module** | |
| **Further responsible persons** | PD Dr. M. Brandsch |
| **Prerequisites** | |
| **Skills to be acquired in this module** | • To understand the basic principles of cell physiology. • To obtain solid knowledge on morphology and function of cell organelles. • To understand the basic techniques of in vitro animal cell cultures. • To know the problematic nature of stem cell research. • To obtain detailed knowledge on transfection of mammalian cells for biotechnological purposes. • To understand the basic principles of plant development • Knowledge of the basic concepts of in vitro plant cell, tissue and organ cultures • Insight into molecular techniques of plant cell transformation and regeneration • Overview of industrial application of plant tissue systems • Insight into biotechnological applications of transgenic plants • Survey of basic techniques of in vitro cultivation of plant cells • Skills of induction and cultivation of plant cells • Skills of handling agrobacteria in plant transformation procedures • Practical knowhow in analyzing genetically modified plants • Theoretical ability to construct a genetically modified organism by gene cloning und ex-pression in a final production host. • Advantages of bacteria, yeast and insect cells as gene expression systems. • Theoretical ability to cultivate bacteria and yeasts. • Overview over products of molecular and classic biotechnology. • Practical know-how for transformation/transfection and cultivation of plant and microbial cells |
| **Module contents** | Course C.1: Animal cell biology and technology • Animal cell morphology and biochemistry • Animal cell physiology • Animal cell lines: Adherent cells, cells in suspension • Basic cell culture techniques: Trypsinization, subculturing, proliferation and viability tests • Transfection techniques • Animal cell mass culture • Special cell types: hybridoma cells<br>Course C.2: Plant cell technology • Plant meristems, vegetative growth and reproductive development • Basic plant regeneration and propagation procedures • Application of organ culture systems • In vitro storage and cryopreservation of plant tissues • Plant cell transformation techniques • Gene expression systems in plants • Molecular plant biotechnology: natural and novel products • Plant cell, tissue and organ cultures: initiation and maintenance • Monitoring of growth parameters and proliferation of plant cell cultures • Agrobacterium-mediated transient expression of reporter genes • Testing transgenic plants for the presence of foreign DNA by PCR • Monitoring of promoter activation based on reporter enzyme activity<br>Course C.3: Molecular Biotechnology • Principal mechanisms of DNA synthesis in vitro and in vivo - use of enzymes for gene cloning. • Regulation of gene expression in prokaryotes and use for heterologous expression of proteins. • Methods of gene cloning and target gene isolation. • Theoretical ability to construct a genetically modified organism for heterologous protein expression. • Theoretical ability to cultivate bacteria and yeasts. • Advantages of bacteria and yeast as gene expression systems.<br>Course C.4: Practical course on construction of hosts and vectors • Amplification of target DNA using PCR, restriction digest and vector ligation. • Transformation of E. coli with plasmid, selection, monitoring of the expression success. |
| **Forms of instruction** | Lecture (1 SWS)<br>Seminar (1 SWS)<br>Lecture (2 SWS)<br>Lecture (2 SWS)<br>Seminar (1 SWS)<br>Practical training (3 SWS)<br>Course |
| **Languages of instruction** | German, English |
| **Duration (semesters)** | 1 Semester Semester |
| **Module frequency** | jedes Wintersemester |
| **Module capacity** | unlimited |

PHA.03533.03 10 CP

| | |
|---|---|
| **Time of examination** | |
| **Credit points** | 10 CP |
| **Share on module final degree** | Course 1: %; Course 2: %; Course 3: %; Course 4: %; Course 5: %; Course 6: %; Course 7: %. |
| **Share of module grade on the course of study's final grade** | 1 |

| Examination | Exam prerequisites | Type of examination |
|---|---|---|
| **Course 1** | | |
| **Course 2** | | |
| **Course 3** | | |
| **Course 4** | | |
| **Course 5** | | |
| **Course 6** | | |
| **Course 7** | | |
| **Final exam of module** | examination on lab course contents part microorganisms, examination on lab course contents part plant cell technology, Protocol on lab course part microorganisms, Protocol on lab course part plant cell technology | Klausur |
| **Exam repetition information** | | |

| Module course label | Course type | Course title | SWS | Workload of compulsory attendance | Workload of preparation / homework etc | Workload of independent learning | Workload (examination and preparation) | Sum workload |
|---|---|---|---|---|---|---|---|---|
| **Course 1** | Lecture | Animal cell biology and technology | 1 | | | | | 0 |
| **Course 2** | Seminar | Animal cell biology and technology | 1 | | | | | 0 |
| **Course 3** | Lecture | Plant cell technology | 2 | | | | | 0 |
| **Course 4** | Lecture | Molecular biotechnology | 2 | | | | | 0 |
| **Course 5** | Seminar | Practical course on construction of hosts and vectors | 1 | | | | | 0 |
| **Course 6** | Practical training | Practical course on construction of hosts and vectors | 3 | | | | | 0 |
| **Course 7** | Course | Selbststudium | | | | | | 0 |
| **Workload by module** | | | | | | 300 | | 300 |
| **Total module workload** | | | | | | | | 300 |