



Advanced Safety Sciences for Medicines M.Sc.

Module manual

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Qualification Aims

Subject-specific and interdisciplinary qualification objectives of the study programme:

Ensuring the safety of medicines begins with research on active ingredients and is a key criterion in the development of new drugs. The master's programme focuses on ethical, regulatory and social aspects of drug safety in all phases of drug research and development, tailored to the practical tasks of everyday work. Particular attention is paid to the interdisciplinary combination of safety assessments provided by sub-disciplines.

Students acquire in-depth knowledge about different areas of drug safety as well as practical skills working on and evaluating real life case studies from our business partners. The courses especially focus on cross-disciplinary aspects of drug safety (translational safety science), i.e. the integration of data from development and toxicology to pre-clinical and clinical phases up to the application in humans. The curriculum also covers the regulatory approval process as well as the production and the mandatory accompanying safety studies for a drug once it has received market approval and has been launched. This helps students to gain a comprehensive understanding of the underlying risks and corresponding safety measures. The students can directly apply the newly acquired knowledge in their daily work routine and are well trained for tasks in a complex work environment.

How the qualification targets take into account the requirements of scientific and non-scientific occupational fields:

The study programme's hybrid structure in collaboration with different national and international universities and partners from industry and public authorities (EMA, BfR, etc.) promotes the establishment of networks as well as the collaboration within the research area. As a rule, the courses are led by a team made up of an academic expert and a business expert. Academic teaching staff is complemented by qualified teachers from (local) businesses, universities and public authorities. Each course consists of:

- a compact phase with four to five days of face-to-face classes (lectures, work on a case study in small groups, discussions)
- a case study to be completed individually (at home) with a workload of one week.

Interdisciplinary qualifications enable *safescimet* students to take on more complex tasks at their workplaces in private-sector (industrial) pharmaceutical research, university research institutions and regulatory authorities. Students will also be encouraged to use the professional and analytical skills they have gained during their studies to approach interdisciplinary issues and integrate intercultural considerations in their daily work routine as well as apply them for the good of society by, for example, investigating the social impacts of increased drug safety. Since the programme is highly interdisciplinary in nature and offers students a wide range of specializations to choose from, the broad perspective our students gain enables them to make solid, goal-oriented decisions in their complex working environments.

Advanced Safety Sciences for Medicines

I. Competences

- The modular concept of the master's study programme in Advanced Safety Sciences for Medicines allows to acquire necessary safety assessment competences that are required during all phases of drug development.
- The five individual modules of the study programme are designed to cover training requirements in translational safety sciences, i.e. the integration of safety data through all disciplines during drug development from component research, toxicology to the pre-clinical and clinical trial phases.
- The Master programme also covers pharmaceutical aspects of drug production as well as the necessary regulatory requirements including the post-marketing safety assessments of a medicines on actual patient groups.
- With this particularly international orientation, the study programme strengthens the European position on safety sciences during drug development.

II. Learning Results

- Module 1 *Drug Discovery and Development* is designed as introduction to drug discovery and drug development as well as to safety aspects of novel therapeutics and stem cell technologies.
- Module 2 *Pharmaceutical Aspects of Drug Safety* covers pharmaceutical and regulatory aspects of safety sciences for medicines.
- Module 3 *Adverse Drug Reactions/Predictive Toxicology* consists of courses on toxicological issues on the biochemical and molecular level as well as on the organic level.
- Module 4 *Non-Clinical Assessment* and Module 5 *Clinical Assessment* focus on translational aspects of pre-clinical and clinical safety data.
- The final masters's module covers the master's examination in form of a written master's thesis on a recent safety problem in industry or other research, based on case-studies and literature review.

Description of Modules

Module 1 - Drug Discovery and Development

Studienprogramm/ Verwendbarkeit

Advanced Safety Sciences for Medicines

Credits	6
Duration	Four study weeks
Part of module of the total rating	- %
Calculation of module grade	Passed / not passed
Module units	1.1 Introduction to Safety Sciences in Drug Discovery and Development 1.2 Drug Safety of Stem Cells and other Novel Therapeutics
Qualification Aims	<p>The introductory course 1.1 will provide participants with a comprehensive overview of drug development with special emphasis on drug safety, enabling them to understand the role of safety sciences in the complex process that brings a new medicine to market. By the end of the course, the students have the appropriate knowledge to outline the key concepts in drug development processes and to communicate them in professional terms. Thus, this module provides an ideal background for the more detailed and specific courses that make up the rest of the programme:</p> <ul style="list-style-type: none"> • Understand the research processes that lead to the identification and selection of chemicals as potential new medicines • Appreciate the role of non-clinical studies in supporting the safety of potential medicines in clinical trials and marketing • Perform basic risk assessments translating non-clinical data to humans in clinical trials • Understand the non-clinical studies required to support safety in different patient populations • Appreciate the importance of clinical study design at different stages in the clinical development process • Understand the importance of post-marketing surveillance for safety issues • Understand how safety is communicated to physicians • Identify the important decision points and milestones in the development process that require internal review and involvement of Regulatory Agencies • Appreciate how the development process may differ for medicines with different modalities • Demonstrate ability to communicate in professional terms about the drug development processes <p>On successful completion of course 1.2, participants will have acquired an understanding of the relevance of stem cells and other novel therapeutics for drug safety research. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • gain an understanding of where the science has reached • appreciate the novelty of these areas and the concomitant challenges to therapy developers and the regulators • understand that there are still many gaps in our knowledge – i.e. concept of an evolving area • understand the basic biology that underpins this field and that is being

- translated into man
- appreciate the utility and possible drawbacks of different preclinical models for assessment of safety
- overview the state of the art in the application of stem cells in safety assessment of conventional compounds

1.1 Introduction to Safety Sciences in Drug Discovery and Development

Teaching content	<ul style="list-style-type: none"> • Drug discovery, targets and target product profiles • Medicinal chemistry, lead optimization and candidate selection • Safety studies and risk assessment to enable first time in human (FTIH) • Design of clinical studies from phase I to phase III • Enabling studies to enroll females of reproductive potential into clinical trials • Evaluation of carcinogenic potential • Regulatory guidance, marketing applications and product labelling • Life-cycle management & pharmacovigilance • Development of biologics and other modalities • Drug metabolism and pharmacokinetics • Safety pharmacology and toxicology • Health economics & patents
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

1.2 Drug Safety of Stem Cells and other Novel Therapeutics

Teaching content	<ul style="list-style-type: none"> • Basic biology of stem cells and molecular therapies - the key issues: efficacy and safety • Drug safety aspects of stem cells and other novel therapeutic approaches • Introduction to immune system and importance in regenerative medicine therapies • Use of stem cells in safety assessment - where we are • Epigenetic Modifying Therapeutics • Oligonucleotides as novel therapies • New nanoparticles and reporters for imaging • Regulatory requirements for adult and embryonal stem cells and novel therapies
Forms of	One-week workshop and self-study

teaching/SWS

Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

Module 2 - Pharmaceutical Aspects of Drug Safety

Studienprogramm/ Verwendbarkeit

Advanced Safety Sciences for Medicines

Credits	9
Duration	Four study weeks
Part of module of the total rating	- %
Calculation of module grade	Passed / not passed
Module units	2.1 Pharmaceutics and Safety 2.2 Regulatory Requirements and Guidelines 2.3 Pharmaco-/ Toxicokinetics and Pharmaco-/ Toxicodynamics
Qualification Aims	<p>On successful completion course 2.1, participants will</p> <ul style="list-style-type: none"> • know and understand the basic concepts of pharmaceutics • be able to apply basic knowledge about administration routes, preformulation and formulation on the design of therapeutically effective medicines • be able to explain the function of pharmaceutical packings and devices used for medication • know the technologies used in the manufacturing of medicines • be able to explain the role of quality systems in the development and manufacturing of medicines <p>On successful completion course 2.2, participants should have an integrated view on the regulatory requirements and guidelines relevant for the development and marketing of new pharmaceuticals. They will understand the type and rationale of the tests required and will identify which data is necessary in each stage of development. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • understand the concept of “relevant species” and recognize the value of its

- use for human extrapolation of nonclinical study outcomes
- plan the nonclinical safety programs for different types of pharmaceuticals and understand the translational aspects of medicines development
- know and understand the European and international nonclinical regulatory guidelines and the situations where they will apply or deviate
- adapt the standard protocols into specific situations, e.g. pathologies, patient populations
- use and integrate the information from multiple sources/ studies as a weight of evidence approach for human risk assessment

- On successful completion course 2.3, participants will be able
- to explain drug absorption, distribution, transport and elimination processes in a physiological context
 - understand the principles of *in vitro* – *in vivo* correlations and interspecies scaling
 - to apply PK/TK principles in ADME(T) discussions
 - explain PD/TD principles and relationships
 - understand modeling aspects of preclinical and clinical PK/TK and PD/TD data
 - understand and explain inter-individual variability in PK/TK
 - apply PK/TK and PD/TD principles in preclinical and clinical drug development

2.1 Pharmaceutics and Safety

Teaching content	<ul style="list-style-type: none"> • Administration routes and drug formulation • General pharmaceutics • Excipients and dosage forms • Packaging and devices • Unit operations and manufacturing • Microbiological aspects, clean room and sterilization • Quality systems and GMP • Regulatory aspects, harmonization between major market regions
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

2.2 Regulatory Requirements and Guidelines

Teaching content	<ul style="list-style-type: none"> • Drug development process and regulatory requirements
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	<ul style="list-style-type: none"> • EU & ICH guidelines and the Common Technical Document • ICH guideline on nonclinical safety • Extrapolation of animal data, human translation and risk assessment • Species selection for nonclinical studies and 3Rs principles • Reproductive toxicity testing, pregnancy labeling • Testing genotoxic and carcinogenic potential • First in Human studies and regulatory guidelines for safe dose estimation • Nonclinical safety testing of biologics • Environmental risk of pharmaceuticals
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

2.3 Pharmaco-/ Toxicokinetics and Pharmaco-/ Toxicodynamics

Teaching content	<ul style="list-style-type: none"> • Basic pharmacokinetic and pharmacodynamic concepts • Drug transport and metabolism • <i>In vitro</i> and <i>in vivo</i> correlations and interspecific scaling • Preclinical applications of ADME(T) • Concentration effect and concentration-toxicity relationships • Causes of inter-individual variance in pharmacokinetics • Principles and applications of PK/PD and TK/TD modeling and strategies in preclinical and clinical drug development
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-

 Compulsory/Optional Optional

Module 3 - Adverse Drug Reactions / Predictive Toxicology / 3 RS

Studienprogramm/ Verwendbarkeit

Advanced Safety Sciences for Medicines

Credits	18
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Duration	Four study weeks
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Part of module of the total rating	- %
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Calculation of module grade	Passed / not passed
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Module units	3.1 Biochemical and Molecular Toxicology: Biotransformation, Bioactivation and Adverse Drug Reactions 3.2 Organ / Systems Toxicology 3.3 Cell Signalling and Predictive Toxicology 3.4 Reproductive Toxicology 3.5 Mutagenesis and Carcinogenesis 3.6 Safety Pharmacology
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Qualification Aims	<p>On successful completion of course 3.1, participants should have an integrated view on the biochemical and molecular aspects of adverse drug reactions, and understand how bioactivation of drug compounds or their metabolites can influence the drug safety profile. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • identify individual drug metabolising enzymes involved in bioactivation and inactivation reactions • recognise circumstances when the body's handling of a drug might be altered resulting in changes to either its safety or efficacy profile • identify safety concerns resulting from active, reactive, and disproportionate metabolites • apply strategies to mitigate risks which consider closely the latest regulatory guidance on metabolites and drug interactions • propose biochemical / molecular mechanisms for specific types of toxicity • interrogate experimental approaches and integrate ADME studies into development plans
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	<p>On successful completion of course 3.2, participants will understand basic reproduction-related pathological findings in a broader context, which will assist them in communicating with specialist pathologists. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • have an appreciation of basic organ functions and their diverse response to toxicity • know and understand the themes and major processes in organ/system toxicity • relate the basics of molecular and physiological response of an organ/system to toxicant insult • be aware of and be able to apply new technologies and methods available for evaluation of organ/system toxicology • design experiments in order to assess and identify specific organ/system toxicity
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- apply relevant parameters to detect organ/system toxicity in the preclinical and clinical setting with statistical methods for risk assessments

On successful completion of course 3.3, participants will have acquired an understanding of the relevance of stem cells and other novel therapeutics for drug safety research. More specifically, participants will be able to

- have an appreciation of basic cell biological responses to injury
- know and understand the themes and major processes in cytotoxicity
- to relate the basics of molecular toxicity to the cellular stress response
- learn about new technologies available for cytotoxicity evaluation
- extrapolate the knowledge from cell level to organ and system (human) levels
- integrate the role of in vitro cytotoxicity evaluation in the context of risk assessment

On successful completion of course 3.4, participants will understand basic reproduction-related pathological findings in a broader context, which will assist them in communicating with specialist pathologists. More specifically, participants will be able to

- have an appreciation of basic organ functions and their diverse response to toxicity
- know and understand the themes and major processes in organ/system toxicity
- relate the basics of molecular and physiological response of an organ/system to toxicant insult
- be aware of and be able to apply new technologies and methods available for evaluation of organ/system toxicology
- design experiments in order to assess and identify specific organ/system toxicity
- apply relevant parameters to detect organ/system toxicity in the preclinical and clinical setting with statistical methods for risk assessments

On successful completion of course 3.5, participants will understand basic principles in chemical mutagenesis and carcinogenesis in a broader context, and will perform risk assessment and risk-benefit evaluations for mutagenic and/or carcinogenic compounds at an advanced level. More specifically, participants will be able to

- understand key cellular and molecular alterations in carcinogenesis
- identify and characterise mutagenic effects of chemical compounds
- elucidate mechanisms of mutagenic and carcinogenic action at the cellular, biochemical and molecular level
- review and assess safety data generated for a mutagenic/carcinogenic compound
- estimate the probability of occurrence of mutagenic and/or carcinogenic effects (risk assessment)
- contribute responsibly to risk-benefit evaluation

On successful completion of course 3.6, participants will be able to

- understand the role of safety pharmacology from drug target identification to market approval and post-marketing pharmacovigilance
- know state of the art approaches analysing how drugs interact with the physiological systems
- appreciate differences in route of administration and of functional changes in the different organ systems
- design testing strategies for issues with safety pharmacology and drug-drug interactions
- be able to integrate in vitro / ex vivo / in vivo models with clinical information
- interpret and extrapolate animal findings to human
- have an awareness of the regulatory requirements for safety pharmacology

- assess and review recent general pharmacology and translational safety pharmacology case studies

3.1 Biochemical and Molecular Toxicology: Biotransformation, Bioactivation and Adverse Drug Reactions

Teaching content	<ul style="list-style-type: none"> • ADME studies and how they are integrated into drug development • Role of drug metabolism in pharmacokinetics, toxicology and clinical adverse drug reactions • Current regulatory guidance on metabolites and drug interactions • Biotransformation of drugs in general but with an emphasis on active, reactive and disproportionate metabolites • Enzymology of drug metabolising enzymes and role of genetic factors • Drug interactions and adverse events resulting from induction or inhibition of human enzymes/transporters • Cellular targets of reactive metabolites and resulting toxicological consequences • Constitutive and inducible defensive systems against reactive metabolites • Hypotheses concerning molecular mechanisms underlying idiosyncratic drug reactions
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

3.2 Organ / Systems Toxicology

Teaching content	<ul style="list-style-type: none"> • Physiology and function of main organ systems • Acute, subchronic and chronic effects • Apical, pre-clinical and clinical endpoints • Mechanistic understanding of toxicity (molecular, biochemical and pathological level) • Distinction between primary organ with subsequent systemic effects from prima facie systemic effects • Extrapolation from animals to human • Experimental design • Principal requirements for the detection, robust analysis and evaluation of endpoints • Statistical evaluation of endpoints and measure for extrapolation
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Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

3.3 Cell Signalling and Predictive Toxicology

Teaching content	<ul style="list-style-type: none"> • Consequences of cell injury and biochemical mechanisms • Adverse Outcome Pathway (AOPs) paradigm • Cellular defence mechanisms against cell stress • Molecular mechanisms of cellular senescence, autophagy or cell death • Intra- and intercellular signalling and mechanisms of cell injury • Translation of cell injury to in vivo models and the clinic • Molecular mechanisms of idiosyncratic drug toxicities and ADR • Stem cell technology and applications in understanding mechanisms of toxicity • Functional genomic technologies • Quantitative high content imaging of drug-induced cellular perturbation for adverse outcome prediction
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

3.4 Reproductive Toxicology

Teaching content	<ul style="list-style-type: none"> • Morphology and physiology of the male and female reproductive tract • Prenatal and postnatal development of mammalian organisms • Standard testing for fertility impairment and developmental toxicity • Developmental neurotoxicity/immunotoxicity • Reproductive toxicity of selected drugs and workplace chemicals • Relevance of maternal toxicity • Pharmacokinetic issues in reproductive toxicology • Endocrine disrupting chemicals • Toxicogenomics in developmental toxicology • Guidelines (ICH, OECD etc)
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

3.5 Mutagenesis and Carcinogenesis

Teaching content	<ul style="list-style-type: none"> • Overview on the biology of carcinogenesis • Principles of mutagenesis and carcinogenesis • Examples of the mutagenic/carcinogenic actions at the cellular, biochemical and molecular level • Experimental design for specific identification of mutagenic/carcinogenic compounds • Interpretation of dose-response curves • Extrapolation of animal findings and experimental data to human • Safety data reports, authority guidelines • Risk-benefit evaluation
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-

Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

3.6 Safety Pharmacology

Teaching content	<ul style="list-style-type: none"> • Organ-specific safety pharmacology: CNS, cardiovascular, respiratory, and other • Use of integrated animal models in safety pharmacology • Telemetric methods • Role of the biological clock • The preclinical regulatory dossier • Safety pharmacology of biologics • Emerging trends in safety pharmacology, including stem cells and biotherapeutics
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

Module 4 - Non-Clinical Assessment

Studienprogramm/ Verwendbarkeit
Advanced Safety Sciences for Medicines

Credits	15
Duration	Four study weeks
Part of module of the total rating	- %
Calculation of	Passed / not passed

module grade	
Module units	<p>4.1 Non-Clinical Safety Assessment Strategies, Ethics and Protocols</p> <p>4.2 Biomolecular Analysis: From Method Development to Clinic</p> <p>4.3 Predictive Cell Culture Systems</p> <p>4.4 Pathology Interpretation in Drug Development</p> <p>4.5 In silico ADME and Predictive Toxicology</p>
Qualification Aims	<p>On successful completion of course 4.1, participants will be able to</p> <ul style="list-style-type: none"> • know regulatory requirements and design strategies for nonclinical safety programmes • understand protocol designs of the full range of nonclinical safety studies • have an overview about species selection criteria, ethical designs, application of the 3 Rs and predictivity of safety studies • appreciate the relation between nonclinical safety and clinical programmes • understand the special requirements for pharmatherapeutics and biotherapeutics • know safety assessment requirements for therapeutic agents including biologics, high risk products and veterinary products • be able to review and assess safety data <p>On successful completion of course 4.3, participants will be able to</p> <ul style="list-style-type: none"> • evaluate studies in the bioanalytical field • understand how the physic-chemical properties of the analytes should be used in the method development of bioanalytical strategies for small molecule drugs • have a basic understanding of widely applied tools for sample pretreatment, separation, and detection in small molecule analysis • define the basic needs for the development of integrated bioanalytical methods for biopharmaceuticals, involving both protein products and (monoclonal) antibodies • critically assess a number of recent developments in the field of biomolecular analysis <p>On successful completion of course 4.3, participants should understand the concepts of clinical safety evaluation prior to drug approval. They should be able to interpret the basic pathways for toxicity in a broader context. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • understand integrated drug development and, in parallel, integrated drug safety evaluation • know and understand translational organ toxicity from animal to man • appreciate the safety concern in the context with the benefit • know and understand the prediction and detection of adverse effects during clinical drug development • know and understand risk assessment methodology • apply a risk evaluation and mitigation strategy <p>On successful completion of course 4.4, participants should understand basic pathological mechanisms of organ-system toxicity. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • have an appreciation of pathological processes • know and understand how different organs respond to injury • understand the approach and terminology that pathologists apply in toxicology • be aware of new technologies and methods available for pathological evaluation • design experiments in order to ensure that pathological samples can be correctly collected, prepared and examined • properly integrate pathology data into the context of human risk assessment

On successful completion of course 4.5, participants should have an integrated hands-on experience with in silico methods for prediction of various ADME/Tox relevant end-points. More specifically, participants will be able to

- gain comprehensive overview of up-to-date in silico methods used in drug discovery and development
- explore and understand the diversity of large datasets
- critically analyse experimental data
- use web-based tools to predict simple ADME/Tox endpoints like drug-likeness, solubility, absorption, genotoxicity, phospholipidosis etc.
- use purpose-developed computational tools for prediction of complex ADME/Tox endpoints like prediction of metabolism and site of metabolism
- understand the principles of the most commonly used types of predictive method

4.1 Non-Clinical Safety Assessment Strategies, Ethics and Protocols

Teaching content	<ul style="list-style-type: none"> • The role of nonclinical safety assessment in drug development • <i>In vitro</i> and <i>in vivo</i> nonclinical study types • Nonclinical safety strategies and principles of protocol design • Safety implication of target choice • Regulatory requirements behind nonclinical safety testing • Investigative toxicology and pathology • Experimental design and application of the 3Rs • Translation from nonclinical to first in human studies • Special approaches and special products • The role of ethics committees
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Forms of teaching/SWS	One-week workshop and self-study
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Work load	90 h
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Credits for this unit	3
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Study/ examination requirements	Case study
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Prerequisites	-
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Language	English
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Frequency of the module	-
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Recommended semester	-
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Compulsory/Optional	Compulsory
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4.2 Biomolecular Analysis: From Method Development to Clinic

Teaching content	<ul style="list-style-type: none"> • Physico-chemical parameters at the basis of method development • Bioanalytical strategies for small molecules: sampling, sample pretreatment, separation, detection, validation, and data handling • General considerations in bioanalytical strategies for biopharmaceuticals • PK/PD and biomarker assay formats • Development of immunogenic assay strategies: background, assay strategies, predictive immunogenicity
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	<ul style="list-style-type: none"> • Integrated bioanalytical assay strategies • Novel developments: therapeutic oligonucleotids, reactive drug metabolites, profiling of body fluids and metabolomics
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

4.3 Predictive Cell Culture Systems

Teaching content	<ul style="list-style-type: none"> • Integrated and translational drug safety • Signal detection and biomarkers • Clinical safety with organ focus on: immune system, liver, kidney, lung, cardiovascular, vascular system, neurotoxicity • Clinical trials methodology and safety issues • Integrated safety management planning • Risk benefit assessment, stratification and management • Risk evaluation, mitigation strategies
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

4.4 Pathology Interpretation in Drug Development

Teaching content	<ul style="list-style-type: none"> • Pathological processes and causes of cell injury. General pathology including acute and chronic inflammation • Pathology of organ systems including the immune, cardiovascular, CNS, kidney, liver and respiratory system, disorders of tissue growth including neoplasia • Introduction to toxicological pathology, integration of anatomic and clinical pathology • Distinguishing spontaneous from test article-related lesions in toxicity studies • Determining adverse versus non-adverse findings • Interpretation and reporting of pathology, including data from carcinogenicity studies • Extrapolation of animal data to human risk assessment • Specialised techniques used in histology and electron microscopy including image analysis
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Optional

4.5 In silico ADME and Predictive Toxicology

Teaching content	<ul style="list-style-type: none"> • Computational tools used in drug discovery and development, with focus on ADME/ Tox • Absorption and distribution from a PK point of view • Critical analysis of experimental data • Prediction of absorption and distribution • Phase I and II metabolism – the Cytochrome P450 enzymes • Prediction of metabolism, • Prediction of site of metabolism • Prediction of toxicity (e.g. genotoxicity, phospholipidosis, hERG etc) • Genomic effects on metabolism and toxicity • Different QSAR systems available
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h

Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

Module 5 - Non-Clinical Assessment

Studienprogramm/ Verwendbarkeit
Advanced Safety Sciences for Medicines

Credits	9
Duration	Four study weeks
Part of module of the total rating	- %
Calculation of module grade	Passed / not passed
Module units	5.1 Clinical Safety: Pre-Approval 5.2 Clinical Safety: Post-Approval 5.3 Personalized medicine: Implications for drug development and treatment
Qualification Aims	<p>On successful completion of course 5.1, participants should understand the concepts of clinical safety evaluation prior to drug approval. They should be able to interpret the basic pathways for toxicity in a broader context. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • understand integrated drug development and, in parallel, integrated drug safety evaluation • know and understand translational organ toxicity from animal to man • appreciate the safety concern in the context with the benefit • know and understand the prediction and detection of adverse effects during clinical drug development • know and understand risk assessment methodology • apply a risk evaluation and mitigation strategy <p>On successful completion of course 5.2, participants should have an integrated view on aspects of adverse drug reactions and risk minimization activities in the post-marketing phase. More specifically, participants will be able to</p> <ul style="list-style-type: none"> • appreciate the need to detect drug-induced adverse effects in relation to recommended therapeutic use, misuse or abuse • know and understand the different kinds of modalities applicable to the detection, analysis and validation of safety signals and drug-induced adverse events

- know study types in pharmaco-epidemiology and designs as a tool for risk assessment and drug safety
- know and understand risk minimization activities post-approval and the measure of their effectiveness
- know the major regulatory issues in post-approval clinical drug safety
- know the quality processes and regulatory inspection and audits in clinical drug safety

On successful completion of course 5.3, participants will be able to

- be aware of technology and methods for identifying mutations and for assessing functional consequences of mutations
- know and understand how genetic polymorphisms of drug metabolizing enzymes and drug transporters can be associated with increased risk of adverse drug reactions
- relate to important examples of useful pharmacogenetic biomarkers for prediction of adverse drug reactions
- know and understand the regulatory guidelines for pharmacogenetics in drug development
- be aware of ethical issues in pharmacogenetics
- properly apply knowledge in the field of pharmacogenetics for future personalized medicine

5.1 Clinical Safety: Pre-Approval

Teaching content	<ul style="list-style-type: none"> • Integrated and translational drug safety • Signal detection and biomarkers • Clinical safety with organ focus on: immune system, liver, kidney, lung, cardiovascular, vascular system, neurotoxicity • Clinical trials methodology and safety issues • Integrated safety management planning • Risk benefit assessment, stratification and management • Risk evaluation, mitigation strategies
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Forms of teaching/SWS	One-week workshop and self-study
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Work load	90 h
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Credits for this unit	3
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Study/ examination requirements	Case study
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Prerequisites	-
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Language	English
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Frequency of the module	-
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Recommended semester	-
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Compulsory/Optional	Compulsory
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5.2 Clinical Safety: Post-Approval

Teaching content	<ul style="list-style-type: none"> • Worldwide regulatory requirements and organization for products safety • Modalities of detection, analysis and validation of safety signals
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	(pharmacovigilance) and risk assessment.
	<ul style="list-style-type: none"> • Pharmacoepidemiology as a tool for the identification and study of drug-induced adverse events and pharmaceutical risk assessment • Risk minimization activities in the post-marketing phase, incl. labelling, medication errors and misuse, and the measure of their effectiveness • Post-approval safety commitments • Quality insurance, inspection and audits • Safety issues and crises
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended semester	-
Compulsory/Optional	Compulsory

5.3 Personalized medicine: Implications for drug development and treatment

Teaching content	<ul style="list-style-type: none"> • Human genome and web accessible databases • Methods to identify mutations and to study their functionality • Clinical important genetic polymorphism of drug metabolizing enzymes • Clinical important genetic polymorphism of drug transporters • Pharmacogenetics of importance for therapy of different types of diseases • Association between certain HLA alleles and adverse drug reactions • Useful pharmacogenomic biomarkers for prediction of adverse reactions • Regulatory guidelines for pharmacogenetics in drug development • Ethical issues in pharmacogenetics and the use of material from biobanks • Personalized medicine in the future
Forms of teaching/SWS	One-week workshop and self-study
Work load	90 h
Credits for this unit	3
Study/ examination requirements	Case study
Prerequisites	-
Language	English
Frequency of the module	-
Recommended	-

semester

Compulsory/Optional Optional
