

# Modulkatalog des Studiengangs Precision Medicine Diagnostics

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# Ziele des Studiengangs

## **Fachliche Qualifikationsziele**

Die Absolventinnen und Absolventen des Studiengangs ... ..

- interpretation of different performance parameters connected with molecular diagnostics in precision medicine as well as an insight into clinical utilisation and quality control
- utilisation of all diagnostic techniques available and evaluation of their diagnostic value
- comprehensive knowledge of medical and natural science issues as well as the current technologies utilised in these fields, particularly in molecular analytics for precision medicine
- provision of validated data allowing physicians to make diagnoses, especially personalized diagnoses
- ability to independently acquire the use of new technologies for precision medicine
- ability to assess and take into account the social, scientific and ethical consequences of findings, decisions and developments in precision medicine
- ability to gather, critically analyse and present complex biomedical data required for precision medicine

## **Überfachliche Qualifikationsziele**

Die Absolventinnen und Absolventen des Studiengangs ... ..

- ability to present results to both an expert and non-expert audience
- ability to work as part of a team particularly in multi-discipline work and research groups
- ability to make scientifically sound decisions independently, taking into account social, scientific and ethical issues
- ability to independently develop scientific and technical expertise in the field of precision medicine
- problem-oriented thinking and independent problem-solving

## **Berufliche Qualifikationsziele**

Die Absolventinnen und Absolventen des Studiengangs ... ..

- ability to take partial or complete responsibility for a project and / or a team
- optimization of professional qualification by fulfilling requirements of a number of job descriptions in precision medicine
- multi-disciplinary education at the interface of medical science, natural science and technology required for precision medicine

# Studiengangstruktur

Modul/ Semester	1	2	3	4	5
3	Thesis				
2	Diagnostics in Selected Fields of Medicine	Research Project	Functional Genomics	High-Throughput Technologies	Omics Technologies
1	Biometrics and Multiparameter Diagnostics	Molecular Diagnostics	Genomics	Management Skills	Predictive Medicine: Identification and Modelling

# Umsetzungsmatrix

Qualifikationsziel	Modul											
	Biometrics and Multiparameter Diagnostics	Molecular Diagnostics	Genomics	Management Skills	Predictive Medicine: Identification and Modelling	Diagnostics in Selected Fields of Medicine	Research Project	Functional Genomics	High-Throughput Technologies	Omics Technologies	Thesis	Summe
comprehensive knowledge of medical and natural science issues as well as the current technologies utilised in these fields, particularly in molecular analytics for precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
provision of validated data allowing physicians to make diagnoses, especially personalized diagnoses	0	0	0	0	0	0	0	0	0	0	0	0
ability to gather, critically analyse and present complex biomedical data required for precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
ability to assess and take into account the social, scientific and ethical consequences of findings, decisions and developments in precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
ability to independently acquire the use of new technologies for precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
utilisation of all diagnostic techniques available and evaluation of their diagnostic value	0	0	0	0	0	0	0	0	0	0	0	0
interpretation of different performance parameters connected with molecular diagnostics in precision medicine as well as an insight into clinical utilisation and quality control	0	0	0	0	0	0	0	0	0	0	0	0
ability to work as part of a team particularly in multi-discipline work and research groups	0	0	0	0	0	0	0	0	0	0	0	0
ability to make scientifically sound decisions independently, taking into account social, scientific and ethical issues	0	0	0	0	0	0	0	0	0	0	0	0
ability to independently develop scientific and technical expertise in the field of precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
ability to present results to both an expert and non-expert audience	0	0	0	0	0	0	0	0	0	0	0	0
problem-oriented thinking and independent problem-solving	0	0	0	0	0	0	0	0	0	0	0	0
optimization of professional qualification by fulfilling requirements of a number of job descriptions in precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
multi-disciplinary education at the interface of medical science, natural science and technology required for precision medicine	0	0	0	0	0	0	0	0	0	0	0	0
ability to take partial or complete responsibility for a project and / or a team	0	0	0	0	0	0	0	0	0	0	0	0

<p style="text-align: center;"><b>Qualifikationsziel</b></p>	<p style="text-align: center;"><b>Modul</b></p> <p style="text-align: center;"><b>Summe</b></p>
comprehensive knowledge of medical and natural science issues as well as the current technologies utilised in these fields, particularly in molecular analytics for precision medicine	<b>0</b>
provision of validated data allowing physicians to make diagnoses, especially personalized diagnoses	<b>0</b>
ability to gather, critically analyse and present complex biomedical data required for precision medicine	<b>0</b>
ability to assess and take into account the social, scientific and ethical consequences of findings, decisions and developments in precision medicine	<b>0</b>
ability to independently acquire the use of new technologies for precision medicine	<b>0</b>
utilisation of all diagnostic techniques available and evaluation of their diagnostic value	<b>0</b>
interpretation of different performance parameters connected with molecular diagnostics in precision medicine as well as an insight into clinical utilisation and quality control	<b>0</b>
ability to work as part of a team particularly in multi-discipline work and research groups	<b>0</b>
ability to make scientifically sound decisions independently, taking into account social, scientific and ethical issues	<b>0</b>
ability to independently develop scientific and technical expertise in the field of precision medicine	<b>0</b>
ability to present results to both an expert and non-expert audience	<b>0</b>
problem-oriented thinking and independent problem-solving	<b>0</b>
optimization of professional qualification by fulfilling requirements of a number of job descriptions in precision medicine	<b>0</b>
multi-disciplinary education at the interface of medical science, natural science and technology required for precision medicine	<b>0</b>
ability to take partial or complete responsibility for a project and / or a team	<b>0</b>

# 1. Semester

<b>Biometrics and Multiparameter Diagnostics</b>					
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 1	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester
<b>1</b>	<b>Lehrveranstaltungen</b> a) Biometrics and Multiparameter Diagnostics b) Design of Clinical Trials	<b>Sprache</b> a) English b) English	<b>Kontaktzeit</b> a) 33,75 Std. b) 22,5 Std.	<b>Selbststudium</b> a) 86,25 Std. b) 37,5 Std.	<b>Geplante Gruppengröße</b> a) 15 b) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students</p> <p><b>Anwendung (3)</b> ... gain knowledge of and learn to apply important reporting guidelines for study planning such as CONSORT, STARD, PRISMA etc. ... are able to plan a straightforward clinical trial including sample size and power calculation</p> <p><b>Analyse (4)</b> ... analyse biomedical data with appropriate statistical procedures ... validate statistical results and models</p> <p><b>Synthese (5)</b> ... write a report for a straightforward clinical trial</p> <p><b>Evaluation / Bewertung (6)</b> ... evaluate a clinical trial ... question the validity of the results of a clinical trial ... select appropriate methods for the statistical analysis</p>				
<b>3</b>	<p><b>Inhalte</b></p> <p>a) Statistical software R, simple parametric probability models, maximum likelihood estimators, minimum distance estimators, robust estimators, exact and asymptotic confidence intervals, bootstrap confidence intervals, basics about statistical tests (type I error, type II error, p value), important statistical tests for categorical and metric data (e.g. t-tests, rank tests), bootstrap and permutation tests, post-hoc testing, 1-way ANOVA, multiple testing</p> <p>b) PIO/PICO, clinical trial registries, useful and reproducible biomedical research, AllTrials initiative, reporting of trials (Equator network), important reporting guidelines (e.g. CONSORT, STROBE, PRISMA, STARD), learning curve, specificities of studies (e.g. in surgery or drug trials), placebo and nocebo, phases of pharmaceutical trials, primary and secondary questions, basic clinical trial designs, randomization, blinding, sample size and power calculation, multiple primary endpoints, group sequential methods, intention-to-treat analysis, types of missing data, imputation of missing data, meta-analysis, evidence based medicine</p>				



4	<p><b>Lehrformen</b></p> <p>a) Seminar</p> <p>b) Vorlesung</p>
5	<p><b>Teilnahmevoraussetzungen</b></p> <p>Fundamentals in mathematics and statistics</p>
6	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1sbL (Laborarbeit) (4 LP)</p> <p>b) Prüfungsleistung 1K (Klausur) (2 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Matthias Kohl (Modulverantwortliche/r)</p> <p>Prof. Dr. Matthias Kohl (Dozent/in)</p>
9	<p><b>Literatur</b></p> <p>a) Hastie, Tibshirani and Friedman (2009). The Elements of Statistical Learning. Springer Verlag. Venables and Ripley (2010). Modern Applied Statistics with S. Springer Verlag. Kohl (2021). Introduction to Statistical Data Analysis in R. Second Edition. bookboon.com</p> <p>b) Friedman LM, Furberg CD, DeMets DL (2010). Fundamentals of clinical trials. Springer Verlag. Chow, Shao and Wang (2008). Sample size calculations in clinical research. Chapman &amp; Hall. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from <a href="http://www.cochrane-handbook.org">www.cochrane-handbook.org</a>.</p>

<b>Molecular Diagnostics</b>					
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 1	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester
<b>1</b>	<b>Lehrveranstaltungen</b> a) Biomarkers in Diagnostics b) Immunological Techniques	<b>Sprache</b> a) English b) English	<b>Kontaktzeit</b> a) 22,5 Std. b) 22,5 Std.	<b>Selbststudium</b> a) 67,5 Std. b) 67,5 Std.	<b>Geplante Gruppengröße</b> a) 15 b) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students ...</p> <p><b>Analyse (4)</b>  ... apply selected high-throughput methods to quantify potential biomarkers  ... describe methods of genomics, transcriptomics, proteomics and metabolomics  ... distinguish between current methods in immunology  ... justify the use of different diagnostic methods  ... use immunological methods to determine immunological parameters  ... evaluate aspects of biomarker patents</p> <p><b>Evaluation / Bewertung (6)</b>  ... compare different applications of biomarkers  ... select suitable methods for biomarker identification and development  ... evaluate literature results</p>				
<b>3</b>	<p><b>Inhalte</b></p> <p>a) Methods in biomarker research and immunology, Examples of DNA/RNA sequencing and transcriptomics, proteomics, metabolomics and immunology, theoretical approaches and regulations for biomarker identification and validation, current applications of biomarkers in diagnosis and prognosis as well as for patient stratification and therapy control, analysis of practical case studies</p> <p>b) Immunological methods, immunological methods in diagnosis and prognosis, as well as patient stratification and therapy control, analysis of practical case studies</p>				
<b>4</b>	<p><b>Lehrformen</b></p> <p>a) Vorlesung b) Vorlesung</p>				
<b>5</b>	<p><b>Teilnahmevoraussetzungen</b></p> <p>Knowledge in biology, molecular biology, biochemistry and instrumental analytics</p>				

6	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1sbK (Klausur) (3 LP)</p> <p>b) Prüfungsleistung 1K (Klausur) (3 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Hans-Peter Deigner (Modulverantwortliche/r)</p> <p>Prof. Dr. Hans-Peter Deigner (Dozent/in)</p>
9	<p><b>Literatur</b></p> <p>a) Biomarkers: In Medicine, Drug Discovery, and Environmental Health. John Wiley &amp; Sons 2010, Editor(s): Vishal S. Vaidya, Joseph V. Bonventre, Lottspeich, Engels (Hrsg.) (2006), Bioanalytik, Spektrum Verlag, 2.Aufl.</p> <p>b) Carl A. Burtis et al. (2012), Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Elsevier, 5. Aufl. Lela Buckingham and Maribeth L. Flaws (2007), Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, F.A. Davis Company.</p>

<b>Genomics</b>						
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 1	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester	
<b>1</b>	<b>Lehrveranstaltungen</b>		<b>Sprache</b>	<b>Kontaktzeit</b>	<b>Selbststudium</b>	<b>Geplante Gruppengröße</b>
	a) Molecular Human Genetics		a) English	a) 22,5 Std.	a) 67,5 Std.	a) 15
	b) Molecular Mechanisms		b) English	b) 22,5 Std.	b) 67,5 Std.	b) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students ...</p> <p><b>Verständnis (2)</b> ... Characterisation of patterns of inheritance in man ... Understanding of human genetic diseases</p> <p><b>Anwendung (3)</b> ... Perform of diagnostical methods to analyse genetic diseases ... Characterisation of genetic causes of human tumors</p> <p><b>Analyse (4)</b> ... Gene therapy: Estimation of chances and risks ... Evaluation of diagnostic results</p> <p><b>Synthese (5)</b> ... Analysis and interpretation of modifications in human genomes ... Reasonable application of gene therapeutical approaches</p> <p><b>Evaluation / Bewertung (6)</b> ... Correlation of genesis and diagnosis of human genetic diseases ... Application of disease specific therapies</p>					
<b>3</b>	<p><b>Inhalte</b></p> <p>a) Human genome, inheritance patterns, genetic diseases, mutations and polymorphisms, genetic diagnostics and consulting, monogenetic, polygenetic and multifactorial diseases (syndromes), methods of diagnostics in human genetics, rare genetic diseases and therapeutical approaches, gene therapy, ethical aspects in context to genetics (e.g. "23 and me"), aspects of the genetic diagnostics law, influence of environmental factors on genetic diseases, viral and non-viral gene shuttling</p> <p>b) Origin and therapy of human tumors, single nucleotide polymorphisms, pharmacogenetics, genetics and effects of pharmaceuticals, epigenetics, signal transduction</p>					

4	<p><b>Lehrformen</b></p> <p>a) Seminar</p> <p>b) Seminar</p>
5	<p><b>Teilnahmevoraussetzungen</b></p> <p>Knowledge in biology, molecular biology and biochemistry</p>
6	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1sbPN (Präsentation) (3 LP)</p> <p>b) Prüfungsleistung 1K (Klausur) (3 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Ulrike Salat (Modulverantwortliche/r)</p> <p>Robert Lukowski (Dozent/in)</p> <p>Sebastian Raimundo (Dozent/in)</p> <p>Prof. Dr. Ulrike Salat (Dozent/in)</p>
9	<p><b>Literatur</b></p> <p>a) Tariverdian, Buselmaier: Humangenetik (Springer Verlag)</p> <p>b) Alberts et al.: Molecular Biology of the Cell (Garland Science)</p>

<b>Management Skills</b>					
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 1	<b>Häufigkeit des Angebots</b> Each semester	<b>Dauer</b> 1 Semester
<b>1</b>	<b>Lehrveranstaltungen</b>	<b>Sprache</b>	<b>Kontaktzeit</b>	<b>Selbststudium</b>	<b>Geplante Gruppengröße</b>
	a) QM and GxP	a) Deutsch	a) 22,5 Std.	a) 37,5 Std.	a) 15
	b) Patent and Trademark Law	b) Deutsch	b) 22,5 Std.	b) 37,5 Std.	b) 15
	c) Laboratory and Project Management	c) Deutsch	c) 22,5 Std.	c) 37,5 Std.	c) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students</p> <p><b>Verständnis (2)</b>  ... understand how to apply for a grant.  ... understand how laboratory and project management works in practice.  ... understand how patent and trademark law works in practice</p> <p><b>Anwendung (3)</b>  ... explain the basic principles of quality management (QM), good working practices (GxP)  ... justify why a good laboratory and project management is of high importance</p>				
<b>3</b>	<p><b>Inhalte</b></p> <p>a) - Quality management standards, ISO 9000 series of standards, quality management principles (QMP) of ISO 9001 in the current version; quality management handbook (structure and chapters), key term "process", standard operation procedures (SOP) and manuals/working instructions (WI), documentation, total-quality-management (TQM), examples.</p> <p>- GCP: Ethical principles for medical research involving human subjects "Declaration of Helsinki", unproven intervention: compassionate use, off-label use, ICH E6 good clinical practice, medical devices (ISO 14155:2011), efficacy guidelines in the context of GCP, principles of ICH GCP, clinical trials</p> <p>- GLP: ISO 17025:2017 and its relation to GLP, GLP implementation in the EU, GLP in the legal framework, Principles of GLP</p> <p>- Interaction of GxP: GMP, GLP, GCP, GPP, GDP</p> <p>b) Intellectual property rights in Europe and Germany:</p> <p>- Major parts/steps of a patent application: request for grant, description of the invention, claims, drawings, abstract.</p> <p>- Decision making between patent and trade secret.</p> <p>- Registered design, different approvals like IVDR.</p> <p>- European Patent Office, European Patent Convention (EPC), Patent Cooperation Treaty (PCT).</p> <p>- Patent searching strategies: International Patent Classification (IPC), Cooperative Patent Classification (CPC).</p> <p>c) - Principles of Project Management</p> <p>- The tasks of the laboratory manager</p> <p>- Principles of Quality Management (QM) and good working practices (GxP)</p> <p>- Principles of Good Clinical Practice (GCP) and Standard Operating Procedures (SOP's) in clinical medicine</p>				

	<ul style="list-style-type: none"> <li>- Management functions</li> <li>- Teams, Team Process and Team Building</li> <li>- Principles of leadership</li> <li>- Motivating other people</li> <li>- Successful communication</li> <li>- Conflict management</li> <li>- Quality management</li> <li>- New Management Concepts</li> <li>- Human resources (HR) management</li> <li>- Regulatory Requirements in Laboratories (FDA, EMEA, ...)</li> <li>- Laboratory Safety and Emergency Management</li> <li>- Clinical Trials and Evidence-Based Laboratory Medicine</li> <li>- Development of a project plan</li> <li>- Content, form and application of a grant</li> </ul>
<b>4</b>	<p><b>Lehrformen</b></p> <ul style="list-style-type: none"> <li>a) Seminar</li> <li>b) Lecture</li> <li>c) Seminar</li> </ul>
<b>5</b>	<p><b>Teilnahmevoraussetzungen</b></p> <p>none</p>
<b>6</b>	<p><b>Prüfungsformen</b></p> <ul style="list-style-type: none"> <li>a) Graded Assessment 1sbL (Laboratory) (2 LP)</li> <li>b) Graded Assessment 1sbH (Written Elaboration) (2 LP)</li> <li>c) Graded Assessment 1sbL (Laboratory) (2 LP)</li> </ul>
<b>7</b>	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
<b>8</b>	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Hans-Peter Deigner (Module Responsible)</p> <p>Hartwig Becker-Feldmann (Lecturer)</p> <p>Markus Bläss (Lecturer)</p> <p>Prof. Dr. Hans-Peter Deigner (Lecturer)</p>

**Literatur**

- a) A Handbook on Good Laboratory Practice (GLP) - By World Health Organization.  
Good Laboratory Practice Regulations. Third Edition, Revised and Expanded. By - Sandy Weinberg.  
Good Clinical Practice (GCP) - ICH Guidelines for European Community and ICH Regions.  
Guidance for Industry. E6 Good Clinical Practice: Consolidated Guidance. By - ICH - for European Community and ICH Regions.
- b) <https://www.dpma.de/english/>  
<https://www.epo.org/>
- c) J. Kuster et al. (2015). Project Management Handbook. Springer.  
A. Gouws (2020). The Guide to Management For Laboratory Leaders: Principles of management in the field of diagnostics. Power of Process (Pty) Ltd.



<b>Predictive Medicine: Identification and Modelling</b>					
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 1	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester
<b>1</b>	<b>Lehrveranstaltungen</b> a) Diagnostics of Microorganisms b) Model Systems	<b>Sprache</b> a) English b) English	<b>Kontaktzeit</b> a) 22,5 Std. b) 22,5 Std.	<b>Selbststudium</b> a) 67,5 Std. b) 67,5 Std.	<b>Geplante Gruppengröße</b> a) 15 b) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b> After successful participation in the module the students ...</p> <p><b>Verständnis (2)</b> ... get knowledge of different model systems, their advantages, disadvantages and limits in research, medicine and testing. ... explain the advantages and disadvantages of a variety of state-of-the-art techniques used in the diagnostics of microorganisms.</p> <p><b>Anwendung (3)</b> ... plan experiments or tests with appropriate model organisms answering specific questions. ... choose appropriate diagnostic methods for a given research question in microbiology.</p> <p><b>Evaluation / Bewertung (6)</b> ... evaluate the strength and weaknesses of published studies with respect to the methods used.</p>				
<b>3</b>	<p><b>Inhalte</b></p> <p>a) overview on the variety of state-of-the-art-methods to isolate, quantify and identify microorganisms and their physiological properties from medically important samples, e.g., aerobic and anaerobic cultivation techniques, PCR, qPCR, molecular fingerprinting techniques, FACS, FISH, MALDI-TOF, FT-IR spectroscopy, NGS, SIP, Metatechnologies etc.</p> <p>b) overview on different types of frequently used models systems, e.g. mice, zebrafish, drosophila, stem cells, yeast, as well as new developed methods (bioengineering) and rare used models; GMO model systems, aspects of animal testing (including legal aspects), planning an experiment with laboratory animals, preclinical animal testing with all legal aspects, discussion on limits by law, ethics and comparability to humans.</p>				
<b>4</b>	<p><b>Lehrformen</b></p> <p>a) Seminar b) Seminar</p>				
<b>5</b>	<p><b>Teilnahmevoraussetzungen</b> B.Sc.-level based-knowledge in (human) biology, molecular biology, biochemistry and (clinical) microbiology</p>				

6	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1sbR (Referat) (3 LP)</p> <p>b) Prüfungsleistung 1sbPN (Präsentation) (3 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Markus Egert (Modulverantwortliche/r)</p>
9	<p><b>Literatur</b></p> <p>a) textbooks on Microbiology; scientific papers (review, original articles) dealing with the respective methods</p> <p>b) scientific papers (review, original articles) dealing with model organisms; textbooks on cell culture, bioengineering, animal models; legal texts (TierSchG, TierSchVerV, ESchG)</p>

## 2. Semester

<b>Diagnostics in Selected Fields of Medicine</b>					
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 2	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester
<b>1</b>	<b>Lehrveranstaltungen</b> a) Internal Medicine / General Medicine b) Pathology	<b>Sprache</b> a) English b) English	<b>Kontaktzeit</b> a) 22,5 Std. b) 22,5 Std.	<b>Selbststudium</b> a) 67,5 Std. b) 67,5 Std.	<b>Geplante Gruppengröße</b> a) 15 b) 15
<b>2</b>	<b>Lernergebnisse/Kompetenzen</b> After successful participation in the module the students ...  <b>Analyse (4)</b> ... classify diagnostic techniques by their application in particular fields of medicine ... distinguish between various disease areas in 1)internal medicine 2)general medicine 3)neurology ... identify pathological processes  <b>Evaluation / Bewertung (6)</b> ... evaluate diagnostic techniques with respect to their diagnostic value				
<b>3</b>	<b>Inhalte</b> a) Pathogenesis, pathology and clinical diagnostics of various diseases from the fields of internal and general medicine b) Pathology: methods and clinical diagnostics in pathology, typical application areas and findings				
<b>4</b>	<b>Lehrformen</b> a) Seminar b) Vorlesung				
<b>5</b>	<b>Teilnahmevoraussetzungen</b> Knowledge in pathophysiology and physiology basic knowledge in electrophysiology (development of actionpotential, function of cell membrane, ionchannels) laboratory diagnostics and imaging methods				
<b>6</b>	<b>Prüfungsformen</b> a) Prüfungsleistung 1sbL (Laborarbeit) (3 LP) b) Prüfungsleistung 1K (Klausur) (3 LP)				
<b>7</b>	<b>Verwendung des Moduls</b> Precision Medicine Diagnostics M.Sc. (PMD)				

<b>8</b>	<b>Modulbeauftragte/r und hauptamtlich Lehrende</b> Prof. Dr. Meike Burger (Modulverantwortliche/r) Prof. Dr. Meike Burger (Dozent/in) Prof. Dr. Katja Kumle (Dozent/in)
<b>9</b>	<b>Literatur</b> a) Herold G: Innere Medizin 2013 Comber und Klimm: Allgemeinmedizin, Thieme Verlag b) Siegfried Schwarz: Pathophysiologie: Molekulare, zelluläre, systemische Grundlagen von Krankheiten, Maudrich Verlag Riede, Werner, Freudenberg: Basiswissen Allgemeine und Spezielle Pathologie, Springer Verlag

Research Project						
Kennnummer	Workload 180 Std.	Credits/LP 6	Studiensemester 2	Häufigkeit des Angebots Each semester	Dauer 1 Semester	
1	<b>Lehrveranstaltungen</b>		<b>Sprache</b>	<b>Kontaktzeit</b>	<b>Selbststudium</b>	<b>Geplante Gruppengröße</b>
	a) Research Project b) Research Seminar		a) Deutsch b) Deutsch	a) 4,5 Std. b) 11,25 Std.	a) 145,5 Std. b) 18,75 Std.	a) 15 b) 15
2	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students ...</p> <p><b>Anwendung (3)</b> ... search through literature databases for relevant scientific publications ... planning of a small research project</p> <p><b>Analyse (4)</b> ... execute a small research project ... present the results of a research project</p> <p><b>Synthese (5)</b> ... report on a scientific project and its results ... write a scientific report for a research project</p> <p><b>Evaluation / Bewertung (6)</b> ... question the results of a scientific project</p>					
3	<p><b>Inhalte</b></p> <p>a) The students will work in small groups independently on various small projects in the field of medical diagnostics b) Instruction and supervision of the research projects, Presentation of the results of the individual projects</p>					
4	<p><b>Lehrformen</b></p> <p>a) Project b) Seminar</p>					
5	<p><b>Teilnahmevoraussetzungen</b></p> <p>Depends on the chosen research project</p> <p>The modules Management Skills, Molecular Diagnostics and Biometrics and Multiparameter Diagnostics should be successfully completed</p>					

6	<p><b>Prüfungsformen</b></p> <p>a) Graded Assessment 1sbA (Practical Work) (5 LP)</p> <p>b) Graded Assessment 1PN (Presentation) (1 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Matthias Kohl (Module Responsible)</p>
9	<p><b>Literatur</b></p> <p>a) Depends on the chosen research project</p> <p>b) Thomas A. Lang (2009). How to Write, Publish, and Present in the Health Sciences: A Guide for Physicians and Laboratory Researchers. American College of Physicians.</p> <p>Michael Jay Katz (2009). From Research to Manuscript: A Guide to Scientific Writing. Springer Verlag.</p>

<b>Functional Genomics</b>					
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 2	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester
<b>1</b>	<b>Lehrveranstaltungen</b> a) Functional Genomics and Instrumental Analytics b) Bioinformatics	<b>Sprache</b> a) English b) English	<b>Kontaktzeit</b> a) 22,5 Std. b) 22,5 Std.	<b>Selbststudium</b> a) 67,5 Std. b) 67,5 Std.	<b>Geplante Gruppengröße</b> a) 15 b) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students ...</p> <p><b>Analyse (4)</b> ... solve theoretical and practical problems in the field of 1) functional genomics and 2) systems biology ... methods of bioinformatic analysis ... identification and quantification of biopolymers like DNA, RNA as well as endogenous metabolites ... select an area of application, identify implementation problems and present an approach to solve potential problems</p> <p><b>Evaluation / Bewertung (6)</b> ... describe and evaluate technologies of instrumental analytics ... select and execute required technologies and approaches for a given analysis ... design a problem-solving approach for applications in diagnosis and therapy control based on methods of functional genomics</p>				
<b>3</b>	<p><b>Inhalte</b></p> <p>a) Methods and analytical approaches in transcriptomics, proteomics, metabolomics and pharmacogenomics; current instrumental methods in sequencing, hybridization and mass spectrometry.</p> <p>b) Applications and data analysis to characterize biological systems and particular biological conditions like diseases and disease stages. Applications in patient stratification, therapy controlling and diagnosis with a focus on individualized therapy as well as case studies.</p>				
<b>4</b>	<p><b>Lehrformen</b></p> <p>a) Vorlesung b) Vorlesung</p>				
<b>5</b>	<p><b>Teilnahmevoraussetzungen</b></p> <p>The modules Molecular Diagnostics, Genomics, as well as Biometrics and Multiparameter Diagnostics should be successfully completed</p>				



6	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1sbK (Klausur) (3 LP)</p> <p>b) Prüfungsleistung 1K (Klausur) (3 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p> <p>Prof. Dr. Hans-Peter Deigner (Modulverantwortliche/r)</p> <p>Prof. Dr. Hans-Peter Deigner (Dozent/in)</p>
9	<p><b>Literatur</b></p> <p>a) Jonathan Pevsner (2009), Bioinformatics and Functional Genomics, Wiley, 2. Aufl. Michael Kaufmann and Claudia Klinger (Eds.) (2012), Functional Genomics: Methods and Protocols, Humana Press, 2. Aufl.</p> <p>b) Edda Klipp et al. (2009), Systems Biology, Wiley-VCH. Eberhard Voit (2012), A First Course in Systems Biology, Garland Science</p>

High-Throughput Technologies					
Kennnummer	Workload	Credits/LP	Studiensemester	Häufigkeit des Angebots	Dauer
	180 Std.	6	2	Jedes Semester	1 Semester
1	Lehrveranstaltungen	Sprache	Kontaktzeit	Selbststudium	Geplante Gruppengröße
	a) Bioanalytical Surfaces	a) English	a) 22,5 Std.	a) 67,5 Std.	a) 15
	b) Epigenetics	b) English	b) 22,5 Std.	b) 67,5 Std.	b) 15
2	Lernergebnisse/Kompetenzen				
	After successful participation in the module the students ...				
	<b>Verständnis (2)</b>				
	... .. get knowledge of different techniques for characterization of epigenetic modifications.				
	... .. get an overview of different immobilization strategies for biomolecules on surfaces/particles (micro/nanoparticles).				
	... .. get knowledge about the definition and principles of epigenetics.				
	... .. get knowledge of different characterization techniques using functionalized surfaces/particles (micro/nanoparticles).				
	... .. get knowledge of different substrate surface/particles (micro/nanoparticles) chemistries, their possible application areas, advantages and disadvantages.				
	... .. get knowledge of the involvement of epigenetic modifications in different physiological and pathophysiological processes.				
	... .. understand the major differences in solid support materials.				
	... .. understand the molecular mechanisms behind epigenetic modifications.				
	<b>Anwendung (3)</b>				
	... .. choose appropriate methods for analysis of defined epigenetic modifications.				
	... .. choose appropriate methods for generation, characterization, and application of defined bioanalytical surfaces/particles (micro/nanoparticles).				
	<b>Evaluation / Bewertung (6)</b>				
	... .. evaluate the strength and weaknesses of published studies with respect to the methods used.				
	... .. evaluate the strengths, weaknesses, and possible application areas of published bioanalytical surfaces/particles (micro/nanoparticles).				
3	Inhalte				
	a) Overview on different surface/particles (micro/nanoparticles) chemistries used for generation of bioanalytical surfaces, Overview of different state-of-the-art-methods for chemical immobilization of biomolecules on surfaces/particles (micro/nanoparticles), possible characterization techniques for assessment of surface functionalization, examples for applications of functionalized surfaces for bioanalytical applications, e.g., Microarrays, Lateral Flow Assays etc.				
	b) Overview on the definition and principles of epigenetics, the molecular mechanisms behind epigenetic modifications and their involvement in (patho-)physiological processes, methods for assessment of epigenetic modifications, e.g, Bisulfite-Sequencing, MeDIP, ChIP, etc.				

4	<p><b>Lehrformen</b></p> <p>a) Seminar</p> <p>b) Vorlesung</p>
5	<p><b>Teilnahmevoraussetzungen</b></p> <p>Knowledge in biology, molecular biology, biochemistry and instrumental analytics.</p>
6	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1sbL (Laborarbeit) (3 LP)</p> <p>b) Prüfungsleistung 1K (Klausur) (3 LP)</p>
7	<p><b>Verwendung des Moduls</b></p> <p>Precision Medicine Diagnostics M.Sc. (PMD)</p>
8	<p><b>Modulbeauftragte/r und hauptamtlich Lehrende</b></p>
9	<p><b>Literatur</b></p> <p>a) Greg T. Hermanson (2013), Bioconjugate Techniques, Academic Press, Third edition</p> <p>b) A. Goldberg, C. Allis, E. Bernstein (2007), Epigenetics: A Landscape Takes Shape, Cell, 128, 635-638</p> <p>U. Deichmann, Epigenetics: The origin and evolution of a fashionable topic, Developmental Biology, 416, 249-254</p>

<b>Omics Technologies</b>						
<b>Kennnummer</b>	<b>Workload</b> 180 Std.	<b>Credits/LP</b> 6	<b>Studiensemester</b> 2	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester	
<b>1</b>	<b>Lehrveranstaltungen</b>		<b>Sprache</b>	<b>Kontaktzeit</b>	<b>Selbststudium</b>	<b>Geplante Gruppengröße</b>
	a) Practical Course		a) English	a) 22,5 Std.	a) 67,5 Std.	a) 15
	b) Data Analysis and Interpretation		b) English	b) 22,5 Std.	b) 67,5 Std.	b) 15
<b>2</b>	<b>Lernergebnisse/Kompetenzen</b> After successful participation in the module the students ...  <b>Analyse (4)</b> ... perform an omics analysis in the lab ... analyse omics data with R, Bioconductor and other software tools  <b>Evaluation / Bewertung (6)</b> ... biological interpretation of results of omics data analysis					
<b>3</b>	<b>Inhalte</b> a) Perform omics experiment in the HFU labs (e.g. sequencing experiments with Oxford Nanopore MinION, lateral flow assay experiments, real-time PCR, qPCR...). b) Steps of the analysis of omics data (quality control, normalization, preprocessing, statistical analysis, enrichment analysis); analyse the data generated in the practical course and write an analysis report including the biological interpretation of the results.					
<b>4</b>	<b>Lehrformen</b> a) Praktikum/Labor b) Seminar					
<b>5</b>	<b>Teilnahmevoraussetzungen</b> Keine Eingabe vorhanden					
<b>6</b>	<b>Prüfungsformen</b> a) Studienleistung 1sbL (Laborarbeit) (3 LP) b) Prüfungsleistung 1sbA (Praktische Arbeit) (3 LP)					
<b>7</b>	<b>Verwendung des Moduls</b> Precision Medicine Diagnostics M.Sc. (PMD)					
<b>8</b>	<b>Modulbeauftragte/r und hauptamtlich Lehrende</b> Prof. Dr. Matthias Kohl (Modulverantwortliche/r)					

**Literatur**

- a) L. Kaiser, S. Vilgis, I. Quint, M. Kohl (2019). Guide to the Practical course 'Omics Technologies'.
- b) R. Gentleman, V.J. Carey, W. Huber, R.A. Irizarry, S. Dudoit (Herausgeber) 2005. Bioinformatics and Computational Biology Solutions Using R and Bioconductor. Springer.  
R. Gentleman (2008). R Programming for Bioinformatics. Chapman & Hall.  
F. Hahne, W. Huber, R. Gentleman, S. Falcon (2008). Bioconductor Case Studies. Springer.

# 3. Semester

<b>Thesis</b>						
<b>Kennnummer</b>	<b>Workload</b> 900 Std.	<b>Credits/LP</b> 30	<b>Studiensemester</b> 3	<b>Häufigkeit des Angebots</b> Jedes Semester	<b>Dauer</b> 1 Semester	
<b>1</b>	<b>Lehrveranstaltungen</b>		<b>Sprache</b>	<b>Kontaktzeit</b>	<b>Selbststudium</b>	<b>Geplante Gruppengröße</b>
	a) Master's Thesis		a) English	a) 0 Std.	a) 810 Std.	a) 15
	b) Thesis Seminar		b) English	b) 11,25 Std.	b) 78,75 Std.	b) 15
<b>2</b>	<p><b>Lernergebnisse/Kompetenzen</b></p> <p>After successful participation in the module the students ...</p> <p><b>Verständnis (2)</b> ... .. can plan and conduct scientific projects (selection of topic, definition of aim and initial working plan, selection and conduction of appropriate experiments, documentation).</p> <p><b>Anwendung (3)</b> ... .. are able to apply gained knowledge / methodology.</p> <p><b>Analyse (4)</b> ... .. can evaluate experimental results and define the further working plan.</p> <p><b>Synthese (5)</b> ... .. can establish and combine different methods with regard to the corresponding experimental aim.</p> <p><b>Evaluation / Bewertung (6)</b> ... ..are able to validate scientific results.</p>					
<b>3</b>	<p><b>Inhalte</b></p> <p>a) The Students should work independently on a individually selected topic.</p> <p>b) The Students should present the core results of their work in a presentation.</p>					
<b>4</b>	<p><b>Lehrformen</b></p> <p>a)</p> <p>b) Seminar</p>					
<b>5</b>	<p><b>Teilnahmevoraussetzungen</b></p> <p>Successful completion of the Research Project Module.</p>					
<b>6</b>	<p><b>Prüfungsformen</b></p> <p>a) Prüfungsleistung 1T (Thesis) (27 LP)</p> <p>b) Studienleistung 1PN (Präsentation) (3 LP)</p>					

<b>7</b>	<b>Verwendung des Moduls</b> Precision Medicine Diagnostics M.Sc. (PMD)
<b>8</b>	<b>Modulbeauftragte/r und hauptamtlich Lehrende</b>
<b>9</b>	<b>Literatur</b> a) Depending on the selected topic.