TECHNISCHE HOCHSCHULE DEGGENDORF

Module Description
Master Life Science Informatics

Faculty Angewandte Gesundheitswissenschaften

LSI-01 INFORMATICS AND BIOMEDICINE

Module code	LSI-01
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Foundations of Science
Course number and name	Informatics Biomedicine
Lecturers	Prof. Dr. Gökçe Aydos Prof. Dr. Melanie Kappelmann-Fenzl
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Informatics and Biomedicine" module aims at providing an in depth understanding of the relevant aspects of molecular biology and informatics. Biomedical research is currently using a variety of computer-based analyses to analyze genes that are predictive for the prognosis or therapy response of a disease ('personalized medicine').

After completing the Informatics and Biomedicine module, students will have obtained the following learning competencies:

Professional competence

Biomedicine

- students are familiar with the basic objectives of biochemical and biophysical processes and their relation to each other

- students understand the functionality of the human body and the effects of alterations on molecular basis
- students understand how molecular alterations cause different kinds of diseases

Informatics

- students are able to navigate within the computer environment via the command line tool
- students can interpret basic commands and understand their architecture
- students have the ability to understand, write and execute commands

Methodological competence

- On the basis of practical examples, students understand what knowledge is required in which areas and therefore also understand the interdisciplinarity between computer science and biomedicine.
- Students are in a position to apply the basic knowledge they have gained across disciplines.

Applicability in this and other Programs

Informatics I, Life Science I, Biomedical Data Analysis

Entrance Requirements

None

Learning Content

Biomedicine

1. Introduction to the cell
2. Basic genetic mechanisms
3. Cells in their social context
4. Cancer
5. Stem Cells and tissue renewal
6. Pathogens and Infections
7. The innate and adaptive immune system

Informatics

1. Computer architecture and programming languages
2. Introduction to Unix/ Linux operating systems
3. Basic command line operations

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises and interactive discus-sions on current topics. The lecture part will prepare students' basic knowledge on medical objectives and the practical exercis-es as well as the interactive discussions will practice students' critical thinking skills.

The computational practical exercises will provide the opportunity to deepen the gained knowledge.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work.

- Bruce Alberts, Alexander Johnson, Peter Walter, Julian Lewis, Martin Raff, Keith Roberts: Molecular Biology of the Cell (Englisch) Gebundene Ausgabe – 2. Dezember 2014; ISBN-13: 9780815344643; ISBN-10: 0815344643
- Stephen R. Bolsover [et al.]: Cell biology : a short course 2nd ed.; ISBN 0-471-26393-1
- William Shotts: The Linux Command Line, 2nd Edition: A Complete Introduction; 2nd Edition; ISBN-13: 978-1593279523

INFORMATICS

Type of Examination

written ex. 45 min.

BIOMEDICINE

Type of Examination

written ex. 45 min.

LSI-02 LIFE SCIENCE I

Module code	LSI-02
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Life Science I
Lecturers	Prof. Dr. Melanie Kappelmann-Fenzl
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Life Science I" module aims at providing an in depth understanding of the relevant aspects of molecular biology. In order to analyze biomedical data professionally, one needs a deep understanding of molecular biological and biochemical processes, which are conveyed within this module.

After completing the Life Science I module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- understand the genetic mechanisms of living organisms and the consequences of genetic alterations
- understand signaling pathways and their repercussions on cell systems
- gain deep knowledge about manipulating/ modifying living systems in the lab and understand the purpose and readout of genetic engineering

Methodological competence

After successfully completing the module, students will:

- be able to differentiate between genetics, transcriptomics and proteomics and have deep insights into their biomedical relevance
- be familiar with genetic engineering methods and experimental procedures and the significance of their results

Applicability in this and other Programs

Biomedical Data Analysis, Sequencing Technologies, Life Science II

Entrance Requirements

None

Learning Content

1. Molecular genetics
   1.1. How cells read the genome
   1.2. Control of gene expression
2. Cell Signaling
3. Genetic engineering

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including exercises and interactive discussions on current topics and publications. The lecture part will prepare students' basic knowledge on biomedical objectives and the exercises as well as the interactive discussions will practice students' critical thinking skills.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work:

- Bruce Alberts, Alexander Johnson, Peter Walter, Julian Lewis, Martin Raff, Keith Roberts: Molecular Biology of the Cell (Englisch) Gebundene Ausgabe – 2. Dezember 2014; ISBN-13: 9780815344643; ISBN-10: 0815344643
- Stephen R. Bolsover [et al.]: Cell biology : a short course 2nd ed.; ISBN 0-471-26393-1

LIFE SCIENCE I

Type of Examination

written ex. 90 min.

LSI-03 INFORMATICS I

Module code	LSI-03
Module coordination	Prof. Dr. Gökçe Aydos
Category	Science
Course number and name	Informatics I
Lecturers	Prof. Dr. Gökçe Aydos
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Informatics I" module aims at providing an in depth understanding of the relevant aspects of computational science. In order to analyze biomedical data professionally, one needs in-depth computing skills, which are conveyed within this module.

After completing the Informatics I module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- have a broad and robust understanding of computer science and programming
- understand concepts like data structures, resource management, software engineering, and web development
- Familiarity in a number of languages, including C, JavaScript plus SQL, CSS, and HTML

Methodological competence

After successfully completing the module, students will:

- Know how to engage with a vibrant community of like-minded learners from all levels of experience
- be familiar with computer settings and handling in terms of computational biology

Applicability in this and other Programs

Biomedical Data Analysis; Informatics II; Data management, Data analysis and Data mining, Bioinformatics: Algorithms and Data Structures; Data visualization

Entrance Requirements

None

Learning Content

1. Product and IT development processes
2. Software development and programming
3. Software architecture
4. Networks
5. Computer hardware
6. Databases
7. Operating Systems
8. Python programming (scripting)

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises. The lecture part will prepare students' basic knowledge on computational objectives and the practical exercises will practice students’ gained knowledge.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work:

- T. Stephens, W. Boucher: Python Programming for Biology: Bioinformatics and Beyond; ISBN-13: 978-0521720090
- William Shotts: The Linux Command Line, 2nd Edition: A Complete Introduction; 2nd Edition; ISBN-13: 978-1593279523

INFORMATICS I

Type of Examination

written ex. 90 min.

LSI-04 BIOSTATISTICS I

Module code	LSI-04
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Biostatistics I
Lecturers	Dr. Meik Kunz
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Biostatistics I" module aims at providing an in depth understanding of the relevant aspects of statistics in terms of biomedical data analysis. In order to analyze biomedical data professionally, one needs in-depth biostatistical knowhow, which is conveyed within this module.

After completing the Biostatistics I module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- have learned how to use the free statistics language R and how to apply the language to biological data sets
- be able to use statistical methods such as descriptive statistics, parametric and non-parametric two-sample tests, chi-square tests, correlation analysis, linear regression analysis and ANOVA.

Methodological competence

After successfully completing the module, students will:

- be safe in dealing with R
- be able to use R for statistical testing of biomedical data
- be familiar with the Bioconductor R packages and their properties and contents

Applicability in this and other Programs

Biomedical Data Analysis; Bioinformatics: Algorithms and Data Structures; Data visualization

Entrance Requirements

None

Learning Content

1. Introducing Statistics
2. Introducing confidence Intervals
3. Continuous Variables
4. P Values and Statistical Significance
5. Challenges in Statistics

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises. The lecture part will prepare students' basic knowledge on biostatistical objectives and the practical exercises will practice students' gained knowledge in biostatistical analysis using the software R.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

- Motulsky, Harvey, M.D.: Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 2014;
- Andy Field: Discovering Statistics Using R; 2012; ISBN-13: 978-1446200469

BIOSTATISTICS I

Type of Examination

written ex. 90 min.

LSI-05 SEQUENCING TECHNOLOGIES

Module code	LSI-05
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Sequencing Technologies
Lecturers	Prof. Dr. Melanie Kappelmann-Fenzl
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Sequencing Technologies" module aims at providing an in depth understanding of the current Sequencing Technologies and their advantages and disadvantages. In order to analyze biomedical data professionally, one needs to understand the different experimental setups of commonly used NGS methods, which are conveyed within this module.
After completing the Sequencing Technologies module, students will have obtained the following learning competencies:
Professional competence

After successfully completing the module, students will:

- have learned how to prepare samples for NGS applications.
- know about common methods of NGS and understand their technology and are able to computationally handle NGS raw data.
- know about the advantages and disadvantages of each sequencing method.

Methodological competence

After successfully completing the module, students will:

- know about the impact of experimental procedures on sample quality.
- know which key data regarding quality and quantity are important for successful sequencing.

Applicability in this and other Programs

Biomedical Data Analysis; master seminar, master thesis

Entrance Requirements

None

Learning Content

1. Experimental setup for NGS applications
2. Sequencing instruments
3. Illumina Sequencers
4. PacBio sequencers
5. Minion sequencers
6. Sequencing data preparation
7. Sequencing data

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including visualization of sequencing technologies. The lecture part will prepare students' basic knowledge on common NGS methods and their applications in research and medicine.

Guest lectures: Illumina, Dr. Silvio Scheel

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work:

o Jianping Xu: Next-Generation Sequencing: Current Technologies and Applications; 2014; ISBN-13: 978-1908230331

SEQUENCING TECHNOLOGIES

Type of Examination

written ex. 90 min.

LSI-06 BIOMEDICAL DATA ANALYSIS

Module code	LSI-06
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Biomedical Data Analysis
Lecturers	Prof. Dr. Melanie Kappelmann-Fenzl
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Biomedical Data Analysis" module shows the students the practical application of computer-aided biomedical data analysis and enables them to carry it out independently. This module is an interdisciplinary tutorial in which the students perform the NGS data analysis workflow by themselves under professional instruction.

After completing the Biomedical Data Analysis module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- have learned how to manage NGS data.
- be familiar with file formats and their usage in the different analysis approaches.
- know about common data analysis workflows and be able to interpret and visualize the achieved results.

Methodological competence

After successfully completing the module, students will:

- be able to perform quality control on sequencing data.
- be able to perform mapping procedures and understand the differences between various mapping algorithms.
- be able to create genome indices and know the relevance of a reference genome.
- be able to perform NGS data analysis in terms of RNA-Seq data.

Applicability in this and other Programs

master seminar, master thesis

Entrance Requirements

None

Learning Content

1. NGS Data- File Formats
2. NGS- Open Sources
3. Reference Genome
4. Mapping
5. Data Analysis- Genomics
   5.1. Variant Calling
6. Data Analysis- Epigenetics
   6.1. ChIP-Seq
   6.2. Methyl-Seq
7. A practical approach: Data Analysis- Transcriptomics
   7.1. Count Table Generation
   7.2. Differential Expression Analysis
   7.3. Differential Exon Usage

Teaching Methods

Tutorial, practical exercises, application examples

The module consists of an interactive theoretical part with blended learning components. Within the tutorial the students use example NGS datasets to perform the biomedical data analysis workflow. In the practical part of the tutorial the students should learn to find solutions to problems independently by discussions and research work.

Guest lectures: Prof. Dr. Dominik Grimm- Machine learning

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

- The Biostars Handbook: Bioinformatics Data Analysis Guide; 2019; https://www.biostarhandbook.com/

BIOMEDICAL DATA ANALYSIS

Type of Examination

written ex. 90 min.

LSI-07 LIFE SCIENCE II

Module code	LSI-07
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Life Science II
Lecturers	Prof. Dr. Melanie Kappelmann-Fenzl
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Life Science II" module builds on the knowledge from "Life Science I" and aims at providing an in depth understanding of the relevant aspects of molecular based diseases with a special focus on molecular oncology. In order to understand the approaches of personalized medicine and targeted therapy the students should have a broad as well as profound knowledge about the ongoing biochemical processes resulting in disease development and progression.

The practice of medicine, especially in the disciplines of Pathology and Genetics is increasingly reliant on Genomic technology. The aim of this module is to increase the knowledge and capability of the students using genetic data allowing them to engage confidently with the scientific concepts of Molecular Pathology and Genomic Medicine.

After completing the Life Science II module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- be able to explain how genetic variation is involved in human disease and the development of cancer.
- understand how genetic variation can be a major determinant of patient treatment.

Methodological competence

After successfully completing the module, students will:

- be able to analyze NGS data in the context of germline mutations that cause human genetic disease, and somatic mutations involved in cancer.
- be able to analyze NGS data in the context of gene expression analysis and understand the relevance of gene set enrichment analysis as well as gene ontology classifications
- be confident in critically evaluate molecular pathology diagnostics.

Applicability in this and other Programs

Data vizualisation, master seminar, master thesis

Entrance Requirements

Recommended or advantageous: Life Science I

Learning Content

Molecular basis of human disease

1. Molecular Pathology

2. Molecular Oncology

Teaching Methods

Seminar-like classes,

The module consists of a lecture part with blended learning components, including interactive discussions on current topics and publications. The lecture part will prepare students' in-depth knowledge on the molecular basis of human disease.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

- William B. Coleman, Gregory J. Tsongalis: Molecular Pathology: The Molecular Basis of Human Disease, 2nd edition, 2017, ISBN-13: 978-0128027615

LIFE SCIENCE II

Type of Examination

written ex. 90 min.

LSI-08 INFORMATICS II

Module code	LSI-08
Module coordination	Prof. Dr. Gökçe Aydos
Category	Science
Course number and name	Informatics II
Lecturers	Prof. Dr. Gökçe Aydos
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Informatics II" module builds on the knowledge from "Informatics I" and aims at providing an in-depth understanding of the relevant aspects of computational science.

After completing the Informatics I module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- be confident in Python programming language and how to use it as a tool for data analysis.
- know how to use computation to help data tell a story.
- be familiar with fundamental principles and methods of visualization.
- know how to use tools widely used by data scientists, such as Jupyter Notebooks etc.

Methodological competence

After successfully completing the module, students will:

- be able to write Python scripts for biomedical approaches.
- know how to use different software tools and know about their application and function.

Applicability in this and other Programs

Data management, Data analysis and Data mining, Bioinformatics: Algorithms and Data Structures; Data visualization

Entrance Requirements

Recommended or advantageous: Informatics I

Learning Content

1. Advanced Python programming language
2. Principles and methods of visualization.
3. Open access tools

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises. The lecture part will prepare students' basic knowledge on computational objectives and the practical exercises will practice students' gained knowledge.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

- T. Stephens, W. Boucher: Python Programming for Biology: Bioinformatics and Beyond; ISBN-13: 978-0521720090
- William Shotts: The Linux Command Line, 2nd Edition: A Complete Introduction; 2nd Edition; ISBN-13: 978-1593279523

INFORMATICS II

Type of Examination

written ex. 90 min.

LSI-09 BIOSTATISTICS II

Module code	LSI-09
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Biostatistics II
Lecturers	Dr. Meik Kunz
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

The "Biostatistics II" module aims at providing an in depth understanding of the relevant aspects of statistics in terms of biomedical data analysis. In order to analyze biomedical data professionally, one needs in-depth biostatistical know-how, which is conveyed within this module.

After completing the Biostatistics I module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- be confident in advanced R programming.
- be able to identify different types of data, and how it can be collected.
- be able to recognize and design experiments.
- know how to summarize data numerically and graphically using R.
- understand the difference between point and interval estimation.
- be able to determine and perform correct statistical tests.

- know how to conclude and interpret the results from statistical tests.
- be familiar with inferential statistics including parametric and nonparametric methods.

Methodological competence

After successfully completing the module, students will:

- be able to write programming scripts in R.
- be able to use R for advanced statistical testing of biomedical data.
- be confident in data visualization in R.

Applicability in this and other Programs

Bioinformatics: Algorithms and Data Structures; Data visualization, master seminar, master thesis

Entrance Requirements

Recommended or advantageous: Biostatistics I

Learning Content

1. Advanced R Programming
2. Identification and collection of different types of data
3. Experiment design
4. Data summary numerically and graphically using R
5. Point and interval estimation
6. Statistical testing
7. Parametric and nonparametric methods

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises. The lecture part will prepare students' basic knowledge on biostatistical objectives and the practical exercises will practice students' gained knowledge in biostatistical analysis using the software R.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

- Motulsky, Harvey, M.D.: Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 2017;
- Andy Field: Discovering Statistics Using R; 2012; ISBN-13: 978-1446200469

BIOSTATISTICS II

Type of Examination

written ex. 90 min.

LSI-10 DATA MANAGEMENT, DATA ANALYSIS & DATA MINING

Module code	LSI-10
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Data Management, Data Analysis & Data Mining
Lecturers	
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

Within the "Data Management, Data Analysis & Data Mining" module the students will acquire fundamental knowledge of the techniques, opportunities and applications of data management, analysis and mining. The module provides an introduction to advanced data analysis techniques as a basis for analyzing NGS data.

After completing the Data Management, Data Analysis & Data Mining module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- be able to identify opportunities for applying data mining of NGS data.
- be familiar with the data mining possibilities and understand their relevance and differences.

Methodological competence

After successfully completing the module, students will:

- know how to manage and store NGS data.
- be able to select and apply appropriate data mining techniques.
- be able to interpret the results.

Applicability in this and other Programs

Bioinformatics: Algorithms and Data Structures; Data visualization, master seminar, master thesis

Entrance Requirements

Recommended or advantageous: Informatics I

Learning Content

1. Goals and Principles of Data Management (Databases)
2. Goals and Principles of Data Analysis (GitHub etc.)
3. Goals and Principles of Data Mining
4. The Data Mining Process (Data Representation and Preprocessing)
5. Clustering
6. Classification
7. Association Analysis

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises. The lecture part will prepare students' basic knowledge on biostatistical objectives and the practical exercises will practice students’ gained knowledge in biostatistical analysis using the software R.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

o Tan, P.-N., Steinback, M.,Kumar, V. (2014). Introduction to Data Mining (2nd Edition). John Wiley & Sons.

o Bianchi V, Ceol A, Ogier AG, et al. Integrated Systems for NGS Data Management and Analysis: Open Issues and Available Solutions. *Front Genet*. 2016;7:75. Published 2016 May 6. doi:10.3389/fgene.2016.00075

DATA MANAGEMENT, DATA ANALYSIS & DATA MINING

Type of Examination

written ex. 90 min.

LSI-11 BIOINFORMATICS- ALGORITHMS AND DATA STRUCTURES

Module code	LSI-10
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Bioinformatics- Algorithms and Data Structures
Lecturers	
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

Within the "Data Management, Data Analysis & Data Mining" module the students will acquire fundamental knowledge of the techniques, opportunities and applications of data management, analysis and mining. The module provides an introduction to advanced data analysis techniques as a basis for analyzing NGS data.

After completing the Data Management, Data Analysis & Data Mining module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- understand essential algorithmic techniques and apply them to solve algorithmic problems.

Methodological competence

After successfully completing the module, students will:

- be able to implement programs that work in less than one second even on massive datasets.
- be able to test and debug code even without knowing the input on which it fails.
- be able to formulate real life computational problems as rigorous algorithmic problems.
- be able to prove correctness of an algorithm and analyze its running time.
- be able to synthesize their knowledge of algorithms and biology to build their own software for solving a biological challenge.

Applicability in this and other Programs

Bioinformatics: Algorithms and Data Structures; Data visualization, master seminar, master thesis

Entrance Requirements

Recommended or advantageous: Informatics I, Biostatistics I

Learning Content

1. Algorithmic Design and Techniques
2. Data Structures Fundamentals
3. Graph Algorithms
4. NP-Complete Problems
5. String Processing and Pattern matching algorithms
6. Dynamic Programming: Applications in Machine learning and Genomics
7. Graph Algorithms in Genome Sequencing
8. Algorithms and Data Structures Capstone

Teaching Methods

Seminar-like classes, application examples

The module consists of a lecture part with blended learning components, including practical exercises. The lecture part will prepare students' basic knowledge on data structures and algorithms and the practical exercises will practice students’ gained knowledge in NGS data analysis using algorithms in R and Python.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work:

- Phillip Compeau, Pavel Pevzner: Bioinformatics Algorithms: An Active Learning Approach, ISBN-13: 978-0990374633

BIOINFORMATICS- ALGORITHMS AND DATA STRUCTURES

Type of Examination

written ex. 90 min.

LSI-11 DATA VISUALIZATION

Module code	LSI-11
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Data Visualization
Lecturers	
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 45 hours virtual learning: 45 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

"Data Visualization" is the graphic representation of a data analysis to achieve clear and effective communication of results and insights. Complex ideas are presented in charts and graphs with the goal of quickly and easily disseminating key, actionable information. Data visualization is an essential part of data science and analytics, especially when working with large, complicated data sets like sequencing data. The visualization tells a story, whether as a stand-along graph or combined with other graphs, charts and design elements in an infographic or dashboard.

After completing the Data Visualization module, students will have obtained the following learning competencies:

Professional competence

After successfully completing the module, students will:

- know the data visualization principles.
- be familiar with file formats and their usage in the different analysis approaches.
- know about common data analysis workflows and be able to interpret and visualize the achieved results.

Methodological competence

After successfully completing the module, students will:

- know how to use ggplot2 in R to create custom plots.
- be able to explore and check alignments with alignment viewers.
- be familiar with genome browsers.

Applicability in this and other Programs

master seminar, master thesis

Entrance Requirements

None

Learning Content

1. R Packages for data visualization
2. Alignment Viewers
3. Genome Browsers
4. Open access visualization tools

Teaching Methods

Tutorial, practical exercises, application examples

The module consists of an interactive theoretical part with blended learning components. Within the tutorial the students use example NGS datasets to perform the biomedical data visualization. In the practical part of the tutorial the students should learn to find various visualization tools, possibilities and methods and discuss their advantages and disadvantages to represent statisitical significance.

Remarks

The iLearn teaching and learning platform provides students with additional literature references and learning material to prepare for the lectures.

Recommended Literature

Detailed lecture notes are available online for preparation and follow-up work

o The Biostars Handbook: Bioinformatics Data Analysis Guide; 2019; https://www.biostarhandbook.com/

DATA VISUALIZATION

Type of Examination

PstA

LSI-12 MASTER THESIS

Module code	LSI-12
Module coordination	Prof. Dr. Melanie Kappelmann-Fenzl
Category	Science
Course number and name	Master Seminar Master Kolloquium Master Thesis
Lecturers	
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Niveau	Postgraduate
Semester periods per week (SWS)	6
ECTS	30
Workload	Time of attendance: 90 hours self-study: 67.5 hours virtual learning: 67.5 hours Total: 1225 hours
Type of Examination	Presentation 20 min., master thesis
Duration of Examination	20 min.
Language of Instruction	English

Module Objective

By producing a Master's Thesis the students should demonstrate their ability to apply the knowledge and skills acquired during the study course, in an independently written scientific work on complex tasks. They thus demonstrate that they have successfully completed their Master's levels studies and acquired the capacity for independent scientific work.

Entrance Requirements

According to the paragraph 8 of the Study and Examination Regulations, those students who have collected at least 40 ECTS credits may register for the Master's Thesis.

Learning Content

The Master's Thesis is a written report in a form of a scientific paper. It describes the scientific findings, as well as the way leading to these findings. It contains justifications for decisions regarding chosen methods for the thesis and discarded alternatives. The student's own substantial contribution to the achieved results has to be evident. In addition, the student presents his work in a colloquium, in which the scientific quality and the scientific independence of his achievements are evaluated. The work on the Master's Thesis is supervised by any of the instructors within the study course (professors or lecturers) or an external instructor. The Master's Thesis can be written on any subject or topic related to the content of any of the modules of the study course. The students can suggest the topics for their Master's Theses according to their research or practice preferences. The preparation time of a Master's Thesis according to the regulations is 6 (six) months. However, an extension up to a maximum of 8 months from the subscription date is possible (§11 APO). As a general rule, the size of the thesis should not exceed 70 pages.

Teaching Methods

Students perform an independent supervised scientific research work.

Recommended Literature

Recommendations and instructions of writing a master's thesis (available through iLearn).

MASTER THESIS

Type of Examination

presentation 20 min., master thesis