INTERNATIONAL BURCH UNIVERSITY

FACULTY OF ENGINEERING AND NATURAL SCIENCES

DEPARTMENT OF GENETICS AND BIOENGINEERING

SECOND CYCLE STUDY PROGRAM SPECIFICATION

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1. PROGRAM DESCRIPTION

1.1 Introduction

Recent advances in the genetics and bioengineering field have triggered a majority of scientific discoveries and inventions in a number of fields including agriculture and medicine. Primary goal of our studies is to translate our understanding of the fundamental concepts into useful processes, devices, therapies and diagnostics that will benefit society and advance human health.

1.2 Vision

Our vision is to create an environment that is dynamic, interdisciplinary, ethic, enterprising, engrossing and modern; one that is open to originality, active in social matters, mindful of human dignity and that produces high quality science.

1.3 Mission

The mission of the Department of Genetics and Bioengineering is to educate its scholars about the principles of life sciences and engineering so that they are able to develop solutions to problems within their chosen fields. Furthermore, the aim is to enhance students' scientific skills, particularly within the disciplines of genetics, bioengineering, and biomolecule design, while emphasizing teamwork, leadership as well as independent and innovative mindsets.

1.4 Program

The genetic and bioengineering Master program includes both a two and one-year program that comprises a mandatory total of 120 ECTS and 60 ECTS credits, respectively. Those students who have successfully completed their Master level studies (appropriate GPA) have the opportunity to continue onto a PhD. The graduate program is competitive – it is designed to provide graduates with experiences and training beyond the research lab, in an effort to prepare them better for the wealth of opportunities available to them, including careers in academia, business and medicine. Some of the main areas of focus are:

- The global role of genetics and bioengineering.
- The role of genetics and bioengineering in business and industry.
- Fundamentals of genetics, bioengineering and data analysis.
- Bioinformatics concepts, applications and design.

1.5 Learning and Teaching

Our learning and teaching methods provide high quality learning opportunities so that candidates effectively demonstrate achievement in the courses and modules in their route of study.

We aim to foster the development of independent study skills, intellectual autonomy as well as a sense of curiosity while encouraging a commitment to lifelong learning and continuous professional development. Furthermore, students are urged to be independent in their course of study by taking on responsibility for their own learning and development. A progressive use of project learning, integrated assessment, and product/problem-based learning allow graduates to take on greater self-direction. Group as well as team work are of particular focus during the scholars' course of study as they provide personal and enriching interactions that shape students both socially and intellectually.

Our courses are usually composed of lectures, seminars and tutorials. The use of simulations, role play, case studies, projects, work-based learning, workshops, peer tutoring, peer group interaction, self-managed teams, and learner-managed learning are some of the means by which effective learning is encouraged.

1.6 Teaching/Learning Methods and Strategies

Lectures/classes: Lectures and classes offer information, literature reviews, illustrative applications and presentations that explore core ideas in the subject matter. Students are expected to solve problems that are discussed in small class setups.

Practical sessions: Genetic and bioengineering methods are taught as a series of laboratory and computer-based experiments with short introductory lectures on theory. This enables a student to understand the issues in the application of molecular biology, genetics, and bioengineering methods in biotechnology and also develop bioinformatics skills relevant to the rest of the course including the research project. Practical sessions, computer-based and experimental lab-based, provide an opportunity for a student to consolidate the theory they have learned about in lectures and apply it to the problems.

Group project: The group project provides an opportunity for students to solve real genetic, bioengineering, and biotechnological problems, practice analytic and problem-solving skills, and work in teams. It is this focus on knowing and doing, on individual achievement as well as meaningful collaborations that enable our students to reach their intellectual and academic potential.

Individual project: Individual projects involve literature reviews, problem specification and experiments/analysis. This enables graduates to utilize theoretical techniques they have learned by applying them in library settings.

Expert (guest) lectures and seminars: Guest lectures and seminars provide graduates with opportunities to hear internal as well as external visiting speakers. Through this immersion in real-world science, students are able to broaden their idea and understanding of the field and to potentially begin visualizing themselves in a science profession.

1.7 Assessment Protocols

The purpose of outcome-based learning assessment is to improve the quality of learning and teaching at the Department of Genetics and Bioengineering. The fundamental principles are:

- Student learning is the central focus of the Department's efforts;
- Each student is unique and will express learning in a unique way;
- Students must be able to apply their learning beyond the classroom;
- Students should become effective, independent, lifelong learners as a result of their educational experience.

Assessment of the GBE Learning Outcomes (GBELOs) begins with the normal assessment process in the major courses that are taken by the students. Each course defines course outcomes and relates the course outcomes to the GBELOs. Students also prepare portfolios that reflect their achievements and capabilities, and the evaluation of the portfolios by a faculty committee represents the final assessment of a student's achievement in the GBELOs.

1.7.1 Assessment

Assessment of intellectual skills is conducted via:

- Written examinations
- Written essay assignments
- Group project report and team presentation
- Individual project report and short presentation

1.7.2. Grading

The final success of a student after all envisioned forms of testing is evaluated and graded through the system of comparison (ECTS) with the scale of grading, as follows:

a) 10 (A) – outstanding performance without errors or with minor errors, carries 95-100 points
b) 9 (B) – above average, with few errors, carries 85-94 points
c) 8 (C) – average, with notable errors, carries 75-84 points
d) 7 (D) – generally good, but with significant shortcomings, carries 65-74 points
e) 6 (E) – meets minimum criteria, carries 55-64 points
f) 5 (F, FX) – performance does not meet minimum criteria, less than 55 points.

1.8 Learning Objectives and Outcomes

Upon completion of the MSc course curriculum, graduates will be:

- Skilled in advanced concepts of genetics and bioengineering necessary for success in various professional or academic endeavors.
- Prepared to pursue career choices in genetics and bioengineering, forensics, bioinformatics, biomedical fields, microbiology, or related interdisciplinary fields that require a strong background in applied sciences, engineering and laboratory experience, all of which are gained through the work on their experiments and thesis.
- Equipped with advanced problem-solving skills, laboratory skills, and design skills for technical careers.
- In possession of communication and teamwork skills as well as ethical behavior necessary to thrive in their careers.
- Able to continue their professional development through continuing their educational endeavors and personal development experiences based on their awareness of database resources and professional societies, journals, and meetings.

Upon completion of the MSc course curriculum, graduates will be able to:

- Show an advanced level of knowledge in the field of genetics and bioengineering.
- Demonstrate an advanced level of knowledge through the merger of genetics and bioengineering with fundamental sciences as well as computer programs necessary for the bioengineering profession.
- Interpret and discuss current topics related to the field.
- Apply computer programs and programming languages necessary in the interpretation of the results of their experiments as well as in their future careers.
- Develop skills to scientifically approach problem solving as well as tasks through the work on various laboratory experiments in the department.
- Apply a progressive level of skills needed to perform routine and advanced laboratory work.
- Master the use of various bioengineering laboratory instruments and machines.
- Perform advanced clinical analysis.

- Collect, analyze and write results obtained through laboratory work in a scientific manner and at the same time be able to publish papers in scientific journals.
- Develop team work skills and abilities to work in a multidisciplinary environment as well as awareness of bioethical and public policy.
- Critically analyze scientific work and identify possibilities for their improvement
- Compare different methodologies and integration of various approaches and design.
- Propose solutions to current problems in the field of genetics and bioengineering.

1.9 Skills and Other Attributes

On successful completion of Master level, students should be able to demonstrate:

- The ability to manage their own learning, and make use of scholarly review and primary sources (for example, referred research articles and/or original materials appropriate to the discipline),
- Effective communication of information, ideas, problems, and solutions to both specialist and non-specialist audiences;
- The qualities and transferable skills requiring the exercise of initiative and personal responsibility, decision-making in complex and unpredictable context, and the learning ability needed to undertake appropriate further training of a professional or equivalent nature.

1.9.1 Intellectual Skills

By the end of the course a student will have developed skills in:

- Synthesis: integrate theory and devise appropriate theoretical models of genetic and bioengineering systems.
- Experimental analysis: acquire, analyze and interpret synthetic and experimental data and understand the strengths and limitations of using each type of experimental data analysis.
- Literature review: ability to critically dissect scientific journal articles.
- Problem solving: apply bioengineering principles to solve different problems.
- Evaluation: interpret experimental data scientifically and demonstrate skills necessary to plan conduct and report on a research project.

1.9.2 Discipline-specific Practical Skills

Upon completion of their Master studies, scholars will have obtained the following attributes:

- Select and apply appropriate computational methods to solve different engineering problems.
- Use genetics and bioengineering technology for the collection and analysis of experimental data.
- Independent undertaking of a research project and completion with minimal supervision/guidance.

1.9.3 Transferable Skills

By the end of the course, a student will have developed a range of transferable skills, including the skills in:

- Managing their own learning and conducting independent thinking and study;
- Problem specification and modelling;
- Applying mathematical and computational methods to solve bioengineering problems;
- Use of bioinformatics to collect data related with the expression of genes, protein, and metabolites from gene databank;

- Managing a research project, including planning and time management;
- Conducting a bioengineering-based research-based work, from hypothesis to report writing;
- Working in a multi-disciplinary team;
- Critical analysis.

1.10 Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning

- Student focus groups and the annual student survey
- Classroom observation of lecturers
- Advanced professional diploma in teaching and learning in higher education
- Membership of the Higher Education Academy
- External examiners reports
- Accreditation visits
- Curriculum area review
- Course committees
- Annual and periodic review.

Mechanisms for the review and evaluation of teaching, learning, assessment, the curriculum and, outcome standards:

- Departmental meeting in June/July at which course tutors consider current course structure, delivery arrangements, student performance in assessment and student feedback, and make recommendations for change and improvement. Also used to help spread best practice for teaching and learning techniques.
- Examiners' reports (both internal and external) on the examinations in a particular year, commenting on pass rates, standards of learning, and examination performance.
- Teaching evaluation questionnaires.
- Annual Course Director's report to the Department Academic Committee with details on admissions, staffing, course changes and feedback, student performance, destination of graduated MSc students, and any difficulties encountered on the course.
- Student destination, whether employment or further study.
- An Advisory Board (from industry and clinical practice) providing occasional and valuable comments on the progress and development of the course from their respective perspectives.

1.11 Indicators of Quality and Standards

- Student feedback
- Retention and success rates for each level for each course
- Student module evaluations
- Annual student questionnaires
- First destination statistics
- Professional accreditation
- External examiner reports

1.12 Criteria for Admission

The Genetics and Bioengineering department at IBU invites applications from candidates whose breadth of knowledge and curiosity suggest a potential for academic excellence.

In general, only applicants with a distinguished academic record will be considered. Recommendations as well as a personal statement are carefully weighed as evidence for qualities we seek in our applicants. Those include evidence of personal skills, communication skills, literacy, numeracy, study skills, subject and motivation, and work experience as well as community involvement.

1.12.1 Academic Ability

a) The applicant academic record to date is indicative of academic excellence during their Master level studies. As part of the application, two or more confidential references, academic transcripts, a personal statement as well as in-person interview will be considered.
b) The applicant has provided sufficient evidence, in the view of the assessor, to suggest that they have the academic ability and commitment to pursue the chosen program to a successful conclusion within the required time limits; an understanding of how a Master level degree will help the applicant progress in their career, and evidence of the ability (prior experience or potential) to work in a multi-disciplinary team.
c) Applicants are normally expected to have achieved an Honors Degree (or equivalent) in engineering, biological and physical sciences, mathematics, computer science subject, or a related subject.

1.12.2 English Language Requirement

Students whose first language is not English are urged to apply, also. However, mastery of the English language is tested via standardized means such as IELTS as well as TOEFL. Candidates are normally expected to meet the following criteria: for IELTS an overall score of 5, for TOEFL an overall score of 180 for the computer-based test, 64 for the internet-based or equivalent score.

1.12.3 Suitability

- The program of study that the applicant wishes to pursue is well-suited to the academic interests and abilities to which they have drawn attention in their application and (where appropriate) the applicant has undertaken any preliminary academic work or course which is normally considered indispensable to acceptance on the proposed program of study.
- The Department of GBE is able to provide appropriate supervision, laboratory, and other facilities for the candidate’s chosen program of work.

2. CURRICULUM (two-year program)

First semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 536	Scientific Research Methods in Genetics and Bioengineering	3	0	6
GBE xxx	Elective I	3	0	6
GBE xxx	Elective II	3	0	6
GBE xxx	Elective III	3	0	6
GBE 595	Seminar I	0	3	6
	Total	**12**	**3**	**30**
Second semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE xxx	Elective IV	3	0	6
GBE xxx	Elective V	3	0	6
GBE xxx	Elective VI	3	0	6
GBE xxx	Elective VII	3	0	6
GBE 596	Seminar II	0	3	6
	Total	**12**	**3**	**30**

Third semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 597	Master's Thesis I	0	0	30
	Total	**0**	**0**	**30**

Fourth semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 598	Master's Thesis II	0	0	30
	Total	**0**	**0**	**30**

3. ELECTIVE COURSES (two-year program)

FIELD GENETICS

CODE	COURSE NAME
GBE 500	MOLECULAR CELL BIOLOGY
GBE 502	BIOTERRORISM
GBE 503	GENETIC TESTING AND COUNSELING
GBE 504	MOLECULAR PRINCIPLES OF VIROLOGY
GBE 505	PURIFICATION TECHNIQUES OF BIOMOLECULES
GBE 506	INTEGRATION OF COMPUTATIONAL AND EXPERIMENTAL BIOLOGY
GBE 507	NUCLEIC ACID AND PROTEIN CHEMISTRY
GBE 508	GENETIC MARKERS
GBE 510	GENETIC DIVERSITY
GBE 511	GMO (GENETICALLY MODIFIED ORGANISMS)
GBE 512	MICROBIAL GENETICS
GBE 514	ADVANCED TOPICS IN BIOINFORMATICS
GBE 515	CANCER BIOLOGY
GBE 516	SYSTEMS NEUROGENETICS
GBE 517	DEVELOPMENTAL BIOLOGY
GBE 518	PHARMACOGENOMICS AND GENE THERAPY
GBE 520	MOLECULAR ANTHROPOLOGY
GBE 521	STEM CELLS
GBE 523	TECHNIQUES IN MOLECULAR BIOLOGY
GBE 525	LABORATORY QUALITY MANAGEMENT SYSTEMS
GBE 530	ANATOMY, PHYSIOLOGY, CELL BIOLOGY WITH HISTOLOGY

FIELD BIOENGINEERING

CODE	COURSE NAME
GBE 501	CELLULAR AND MOLECULAR ENGINEERING
GBE 505	PURIFICATION TECHNIQUES OF BIOMOLECULES
GBE 506	INTEGRATION OF COMPUTATIONAL AND EXPERIMENTAL BIOLOGY
GBE 509	BIOMEDICAL TELEMETRY
GBE 511	GMO (GENETICALLY MODIFIED ORGANISMS)
GBE 513	ADVANCED TOPICS IN BIOENGINEERING
GBE 514	ADVANCED TOPICS IN BIOINFORMATICS
GBE 516	SYSTEMS NEUROGENETICS
GBE 518	PHARMACOGENOMICS AND GENE THERAPY
GBE 519	OMICS TECHNOLOGY
GBE 522	ETHICS AND PUBLIC POLICY IN BIOENGINEERING
GBE 524	NANOTECHNOLOGY AND NANOSENSORS
GBE 525	LABORATORY QUALITY MANAGEMENT SYSTEMS
GBE 526	BIOMEDICAL DATA AND ANALYSIS
GBE 527	BIOMEDICAL INSTRUMENTATION AND MEASUREMENT
GBE 528	MEDICAL IMAGING AND IMAGE PROCESSING
GBE 529	BIOMATERIALS AND ARTIFICIAL ORGANS
GBE 537	SCIENTIFIC RESEARCH METHODS IN BIOMEDICAL ENGINEERING

4. CURRICULUM (one-year program)

First semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 536	Scientific Research Methods in Genetics and Bioengineering	3	0	6
GBE xxx	Elective I	3	0	6
GBE xxx	Elective II	3	0	6
GBE xxx	Elective III	3	0	6
GBE 595	Seminar I	0	3	6
	Total	**12**	**3**	**30**

Second semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE xxx	Elective IV	3	0	6
GBE xxx	Elective V	3	0	6
GBE 599	Master's Thesis	0	0	18
	Total	**6**	**0**	**30**

5. ELECTIVE COURSES (one-year program)

FIELD GENETICS

CODE	COURSE NAME
GBE 500	MOLECULAR CELL BIOLOGY
GBE 502	BIOTERRORISM
GBE 503	GENETIC TESTING AND COUNSELING
GBE 504	MOLECULAR PRINCIPLES OF VIROLOGY
GBE 505	PURIFICATION TECHNIQUES OF BIOMOLECULES
GBE 506	INTEGRATION OF COMPUTATIONAL AND EXPERIMENTAL BIOLOGY
GBE 507	NUCLEIC ACID AND PROTEIN CHEMISTRY
GBE 508	GENETIC MARKERS
GBE 510	GENETIC DIVERSITY
GBE 511	GMO (GENETICALLY MODIFIED ORGANISMS)
GBE 512	MICROBIAL GENETICS
GBE 514	ADVANCED TOPICS IN BIOINFORMATICS
GBE 515	CANCER BIOLOGY
GBE 516	SYSTEMS NEUROGENETICS
GBE 517	DEVELOPMENTAL BIOLOGY
GBE 518	PHARMACOGENOMICS AND GENE THERAPY
GBE 520	MOLECULAR ANTHROPOLOGY
GBE 521	STEM CELLS
GBE 523	TECHNIQUES IN MOLECULAR BIOLOGY
GBE 525	LABORATORY QUALITY MANAGEMENT SYSTEMS
GBE 530	ANATOMY, PHYSIOLOGY, CELL BIOLOGY WITH HISTOLOGY

FIELD BIOENGINEERING

CODE	COURSE NAME
GBE 501	CELLULAR AND MOLECULAR ENGINEERING
GBE 505	PURIFICATION TECHNIQUES OF BIOMOLECULES
GBE 506	INTEGRATION OF COMPUTATIONAL AND EXPERIMENTAL BIOLOGY
GBE 509	BIOMEDICAL TELEMETRY
GBE 511	GMO (GENETICALLY MODIFIED ORGANISMS)
GBE 513	ADVANCED TOPICS IN BIOENGINEERING
GBE 514	ADVANCED TOPICS IN BIOINFORMATICS
GBE 516	SYSTEMS NEUROGENETICS
GBE 518	PHARMACOGENOMICS AND GENE THERAPY
GBE 519	OMICS TECHNOLOGY
GBE 522	ETHICS AND PUBLIC POLICY IN BIOENGINEERING
GBE 524	NANOTECHNOLOGY AND NANOSENSORS
GBE 525	LABORATORY QUALITY MANAGEMENT SYSTEMS
GBE 526	BIOMEDICAL DATA AND ANALYSIS
GBE 527	BIOMEDICAL INSTRUMENTATION AND MEASUREMENT
GBE 528	MEDICAL IMAGING AND IMAGE PROCESSING
GBE 529	BIOMATERIALS AND ARTIFICIAL ORGANS
GBE 537	SCIENTIFIC RESEARCH METHODS IN BIOMEDICAL ENGINEERING

SYLLABI

Course Code: GBE 536	**Course Name:** SCIENTIFIC RESEARCH METHODS IN GENETICS AND BIOENGINEERING		
Level: Master	**Year:** I	**Semester:** I	**ECTS Credits:** 6
Status: Mandatory	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is introducing the nature of research in natural sciences, most prominently in genetics and bioengineering. All phases of designing and performing the research, converting obtained data into meaningful results, and result presentation through scientific articles are covered during the course. This course is explaining how to perform literature review for the purpose of different types of scientific articles, how to collect primary data, and how to report the results. Also, the basic ethical principles that are to be applied during the research are discussed. At the end of semester, students are supposed to analyze original scientific articles and case studies in order to understand the difference. Active student participation and preparation of high quality presentations are of the highest importance.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Teaching research methodology concepts in the field of genetics and bioengineering theoretically and practically. ● Enabling graduates to report a research study and thesis proposal in their areas of interest during the semester. ● Encouraging graduates to deliver effective presentations of their research.		
Course Content (weekly plan)	The nature of research in genetics and bioengineering Formulating and clarifying research topic, objectives, and goals Making differences between case study, review, and original scientific paper Critically reviewing scientific literature Understanding research materials and methods, philosophies, and approaches Formulating experimental research design Negotiating access and research ethics **: MID-TERM EXAM** Selecting and collecting samples 0: Collecting primary data through observations and experiments 1: Collecting primary data using different analytical tools 2: Presentation of achieved results 3: Analyzing original scientific articles 4: Analyzing case study articles 5: Writing and presenting presentations on research application in genetics and bioengineering **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	30 %	Final Exam	30 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Begin to work effectively as part of a team 2. Develop interpersonal, organizational and problem-solving skills within a managed environment 3. Exercise some personal responsibility 4. Present gained results 5. Interpret scientific data 6. Cite literature properly
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Various scientific papers in the field of GBE.
Recommended Literature	None

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 595	**Course Name:** SEMINAR I		
Level: Master	**Year:** I	**Semester:** I	**ECTS Credits:** 6
Status: Mandatory	**Hours/Week:** 0+3		**Total Hours:** 0+45
Course Description	This course is designed to guide students through the process of initiating a graduate project. Starting from the selection of topics and fields of interest, throughout the development of the research proposal and methodologies, this course covers all the initial stages of project development. The graduate project is the capstone requirement of a student's program, and, therefore, is normally conducted upon completion of core and specialization coursework.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Familiarizing graduates with the process of academic research and writing. ● Assisting graduates in the development of critical thinking skills, research methodologies, academic writing, synthesis and integration. ● Explaining the application of concepts and principles acquired.		
Course Content (weekly plan)	Week 1: Course introduction Week 2: Introduction to research; Experimental analysis and design Week 3: Communicating scientific information; Types of scientific articles Week 4: Scientific misconduct; Scientific referencing Week 5: Scientific publishing Week 6: Ethics in life science research Week 7: Student presentations **WEEK 8: MID-TERM EXAM** Week 9: Guest lecture Week 10: Guest lecture Week 11: Guest lecture Week 12: Guest lecture Week 13: Student-mentor communication Week 14: Student-mentor communication Week 15: Student-mentor communication **WEEK 16: FINAL EXAM (MASTER THESIS TOPIC PROPOSAL PRESENTATIONS)**		
Teaching Methods Description	● Interactive lectures ● Discussions and group works ● Mentor-candidate communication ● Guest lectures		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	0 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	30 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Finalize a topic for the research paper requirement 2. Identify an appropriate research design 3. Conduct appropriate research activities 4. Write an elaborate research paper 5. Deliver an effective presentation about the research conducted
Prerequisite Course(s) (if any)	None
Language of Instruction	English

Mandatory Literature	Selection of literature depends on chosen individual topics. Marder, P.M. (2011). *Research Methods for Science*. Cambridge, UK: Cambridge University Press
Recommended Literature	● Russey, W. E., Ebel, H. F., & Bliefert, C. (2006). How to write a successful science thesis. The concise guide for students. Weinheim: Wiley-VCH. ● Evans, D., Gruba, P., & Zobel, J. (2011). How to write a better thesis. Melbourne: Melbourne Univ. Publishing. ● Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2013). Proposals that work: A guide for planning dissertations and grant proposals. Thousand Oaks: SAGE Publications, Incorporated.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lectures and student-mentor communication (15 weeks x hours/week)	15	3	45
Midterm examination	1	3	3
Final examination	1	3	3
Preparation for midterm exam	1	25	25
Presentation (with preparation)	1	15	15
Research	1	45	45
Preparation of research report	1	20	20
Total Workload			156
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 596	**Course Name:** SEMINAR II		
Level: Master	**Year:** I	**Semester:** II	**ECTS Credits:** 6
Status: Mandatory	**Hours/Week:** 0+3		**Total Hours:** 0+45
Course Description	This course is designed to guide students through the process of initiating a graduate project. Starting from the selection of topics and fields of interest, throughout the development of the research proposal and methodologies, this course covers all the initial stages of project development. The graduate project is the capstone requirement of a student's program, and, therefore, is normally conducted upon completion of core and specialization coursework.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Familiarizing graduates with the process of academic research and writing. ● Assisting graduates in the development of critical thinking skills, research methodologies, academic writing, synthesis and integration. ● Explaining the application of concepts and principles acquired.		
Course Content (weekly plan)	● Identifying an appropriate graduate project. ● Identifying an appropriate site to conduct the graduate project. ● Planning the graduate project, including completing a written project plan. ● Submitting all forms necessary to start working on the graduate project. ● Obtaining approval from the advisor to conduct the graduate project. ● Initiating the graduate project.		
Teaching Methods Description	● Interactive lectures		

	● Discussions and group works ● Mentor-candidate communication			
Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	50 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	50 %	Final Exam	0 %
	Total	**100 %**		
Learning Outcomes	After completion of this course, students should be able to: 1. Finalize a topic for the research paper requirement 2. Identify an appropriate research design 3. Conduct appropriate research activities 4. Write an elaborate research paper 5. Deliver an effective presentation about the research conducted			
Prerequisite Course(s) (if any)	None			
Language of Instruction	English			
Mandatory Literature	Selection of literature depends on chosen individual topics.			
Recommended Literature	● Russey, W. E., Ebel, H. F., & Bliefert, C. (2006). How to write a successful science thesis. The concise guide for students. Weinheim: Wiley-VCH. ● Evans, D., Gruba, P., & Zobel, J. (2011). How to write a better thesis. Melbourne: Melbourne Univ. Publishing. ● Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2013). Proposals that work: A guide for planning dissertations and grant proposals. Thousand Oaks: SAGE Publications, Incorporated.			

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Literature review (15 weeks x hours/week)	15	3	45
Research /Laboratory/ field work	1	50	50
Reporting	1	20	20
Seminar / Presentation	1	40	40
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 597</td><td colspan="4">Course Name: MASTER’S THESIS I</td></tr>
<tr><td>Level: Master</td><td>Year: II</td><td colspan="2">Semester: I</td><td>ECTS Credits: 30</td></tr>
<tr><td>Status: Mandatory</td><td colspan="2">Hours/Week: 0+0</td><td colspan="2">Total Hours: 0+0</td></tr>
<tr><td>Course Description</td><td colspan="4">Master’s thesis is done throughout two semesters/one academic year. During that time, each graduate student is expected to independently work on a chosen research project and apply different genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study. Ideally, they should start publishing scientific papers in recognized scientific journals as a means of reporting obtained results. At the end of their Master’s studies, each student should submit a Master’s thesis and defend it in the form of oral presentation in front of a committee consisted of three juries.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
● Explaining how to write a literature review.
● Giving an outline of important issues in a specific field and explaining the scientific approach to research questions.
● Teaching how to carry out a scientific study and appropriately manage its data.
● Providing an overview of ethics involved in animal and/or human research.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">● Reviewing literature related to the topic of Master’s thesis.
● Independent experimental work under the direction of a supervisor on a research problem in the student's designated area of research.
● Data collection and analysis and result presentation.
● Writing a Master’s thesis in which major findings of the research will be presented and compared to the previously published literature.
● Defending Master’s thesis in the form of oral presentation.</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">● Discussions and group works
● Mentor-candidate communication</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>50 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>0 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>50 %</td><td>Final Exam</td><td>0 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Finalize a topic for the research paper requirement
2. Identify an appropriate research design
3. Conduct appropriate research activities
4. Write an elaborate research paper
5. Deliver an effective presentation about the research conducted</td></tr>
<tr><td>Prerequisite Course(s)
(if any)</td><td colspan="4">None</td></tr>
<tr><td>Language of Instruction</td><td colspan="4">English</td></tr>
<tr><td>Mandatory Literature</td><td colspan="4">Russey, W. E., Ebel, H. F., & Bliefert, C. (2006). How to write a successful science thesis. The concise guide for students. Weinheim: Wiley-VCH.</td></tr>
<tr><td>Recommended Literature</td><td colspan="4">Evans, D., Gruba, P., & Zobel, J. (2011). How to write a better thesis. Melbourne: Melbourne Univ. Publishing.</td></tr>
</table>

	Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2013). Proposals that work: A guide for planning dissertations and grant proposals. Thousand Oaks: SAGE Publications, Incorporated.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultations	1	250	250
Research/ Laboratory/ field work	1	150	150
Thesis writing process	1	100	100
Data analysis and Reporting	1	150	150
Seminar / Presentation (including defense)	1	100	100
Total Workload			750
ECTS Credit (Total Workload / 25)			30

<table>
<tr><td>Course Code: GBE 598</td><td colspan="4">Course Name: MASTER’S THESIS II</td></tr>
<tr><td>Level: Master</td><td>Year: II</td><td colspan="2">Semester: IV</td><td>ECTS Credits: 30</td></tr>
<tr><td>Status: Mandatory</td><td colspan="2">Hours/Week: 0+0</td><td colspan="2">Total Hours: 0+0</td></tr>
<tr><td>Course Description</td><td colspan="4">Master’s thesis is done throughout two semesters/one academic year. During that time, each graduate student is expected to independently work on a chosen research project and apply different genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study. Ideally, they should start publishing scientific papers in recognized scientific journals. At the end of their Master’s studies, each student should submit a Master’s thesis and defend it in the form of oral presentation in front of a committee consisted of three juries.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Explaining how to write a literature review.
Giving an outline of important issues in a specific field and explaining the scientific approach to research questions.
Teaching how to carry out a scientific study and appropriately manage its data.
Providing an overview of ethics involved in animal and/or human research.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Reviewing literature related to the topic of Master’s thesis.
Independent experimental work under the direction of a supervisor on a research problem in the student's designated area of research.
Data collection and analysis and result presentation.
Writing a Master’s thesis in which major findings of the research will be presented and compared to the previously published literature.
Defending Master’s thesis in the form of oral presentation.</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Discussions and group works
Mentor-candidate communication</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>50 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>0 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>50 %</td><td>Final Exam</td><td>0 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Finalize a topic for the research paper requirement
2. Identify an appropriate research design
3. Conduct appropriate research activities
4. Write an elaborate research paper
5. Deliver an effective presentation about the research conducted</td></tr>
<tr><td>Prerequisite Course(s)
(if any)</td><td colspan="4">None</td></tr>
<tr><td>Language of Instruction</td><td colspan="4">English</td></tr>
<tr><td>Mandatory Literature</td><td colspan="4">Russey, W. E., Ebel, H. F., & Bliefert, C. (2006). How to write a successful science thesis. The concise guide for students. Weinheim: Wiley-VCH.</td></tr>
<tr><td>Recommended Literature</td><td colspan="4">Evans, D., Gruba, P., & Zobel, J. (2011). How to write a better thesis. Melbourne: Melbourne Univ. Publishing.
Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2013). Proposals that work: A guide for planning dissertations and grant proposals. Thousand Oaks: SAGE</td></tr>
</table>

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultation	1	250	250
Research/ Laboratory/ field work	1	150	150
Thesis writing process	1	100	100
Data Analysis and Reporting	1	150	150
Seminar / Presentation (including defense)	1	100	100
Total Workload			750
ECTS Credit (Total Workload / 25)			30

Course Code: GBE 599	**Course Name:** MASTER'S THESIS			
Level: Master	**Year:** II	**Semester:** II	**ECTS Credits:** 18	
Status: Mandatory	**Hours/Week:** 0+0		**Total Hours:** 0+0	
Course Description	Master's thesis is done throughout one semester in one academic year. During that time, each graduate student is expected to independently work on a chosen research project and apply different genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study. Ideally, they should start publishing scientific papers in recognized scientific journals. At the end of their Master's studies, each student should submit a Master's thesis and defend it in the form of oral presentation in front of a committee consisted of three juries.			
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Explaining how to write a literature review. ● Giving an outline of important issues in a specific field and explaining the scientific approach to research questions. ● Teaching how to carry out a scientific study and appropriately manage its data. ● Providing an overview of ethics involved in animal and/or human research.			
Course Content (weekly plan)	● Reviewing literature related to the topic of Master's thesis. ● Independent experimental work under the direction of a supervisor on a research problem in the student's designated area of research. ● Data collection and analysis and result presentation. ● Writing a Master's thesis in which major findings of the research will be presented and compared to the previously published literature. ● Defending Master's thesis in the form of oral presentation.			
Teaching Methods Description	● Discussions and group works ● Mentor-candidate communication			
Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	50 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	50 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Finalize a topic for the research paper requirement 2. Identify an appropriate research design 3. Conduct appropriate research activities 4. Write an elaborate research paper 5. Deliver an effective presentation about the research conducted
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Russey, W. E., Ebel, H. F., & Bliefert, C. (2006). How to write a successful science thesis. The concise guide for students. Weinheim: Wiley-VCH.
Recommended Literature	Evans, D., Gruba, P., & Zobel, J. (2011). How to write a better thesis. Melbourne: Melbourne Univ. Publishing. Locke, L. F., Spirduso, W. W., & Silverman, S. J. (2013). Proposals that work: A guide for planning dissertations and grant proposals. Thousand Oaks: SAGE

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultation	1	100	100
Research/ Laboratory/ field work	1	100	100
Thesis writing process	1	100	100
Data Analysis and Reporting	1	100	100
Seminar / Presentation (including defense)	1	50	50
Total Workload			450
ECTS Credit (Total Workload / 25)			18

Course Code: GBE 500	**Course Name:** MOLECULAR CELL BIOLOGY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	The first part of this course is organized as a guide through the basic cell biology necessary for understanding processes related to nucleic acids and proteins that are occurring within the cell. However, the majority of the course is related to molecular biology principles, which includes advanced topics in DNA replication, transcription and translation, RNA processing, post-translational modifications, and protein folding and ubiquitination. Small RNAs are covered as a separate topic since this is a novel and exciting field in both theoretical and experimental molecular biology.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Explaining the basics of cell biology. ● Demonstrating DNA replication and repair mechanisms. ● Revising the central dogma of molecular biology. ● Teaching the regulation of gene expression.		
Content plan)	Introduction to the course Basic cell biology: Cellular organelles and membranes Basic cell biology: Cell signaling and membrane transport Basic cell biology: Cell cycle, division, and apoptosis DNA replication and repair mechanisms Central dogma of molecular biology: Transcription Central dogma of molecular biology: RNA splicing and processing **: MID-TERM EXAM** Central dogma of molecular biology: Translation 0: Central dogma of molecular biology: Post-translational modifications 1: DNA topology and chromatin 2: Regulation of gene expression 3: Protein folding. Protein secondary and tertiary structure 4: Protein ubiquitination 5: Small RNAs **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations (4-5 students per semester)		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Recall the basics of cell biology 2. Clarify DNA replication and repair mechanisms 3. Repeat theory and application of gene expression mechanisms 4. Demonstrate the central dogma of molecular biology 5. Explain protein folding

Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Berk, A., & Zipursky, S. L. (2000). Molecular cell biology (Vol. 4). New York: WH Freeman.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 501</td><td colspan="4">Course Name: CELLULAR AND MOLECULAR ENGINEERING</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td colspan="2">Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td colspan="2">Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="4">This course provides comprehensive coverage of molecular engineering, beginning with a historical perspective and basic principles of molecular cell biology. It covers tools and models used in biomedical engineering, synthetic biomaterials, bioreactors, and drug delivery. Signal transduction in an engineered tissue and stem cell engineering are of the special concern in this module. Finally, medical ethics and future projections in the field are discussed. This course gives fundamental knowledge to all practicing biomedical engineers and geneticists.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Teaching the basics of transport phenomena and biomimetic systems.
Illustrating physiological modeling basics.
Explaining the fundaments of stem cell engineering.
Explaining the concept of artificial organs and personalized medicine.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Molecular biology: Historical perspective and basic molecular biology
Molecular biology: Expression in mammalian cell
Transport phenomena and biomimetic systems: Concept, design, and emulation
Transport phenomena and biomimetic systems: Transport and drug delivery through the blood-brain barrier and cerebrospinal fluid
Physiological modeling, simulation, and control: Modeling strategies and cardiovascular dynamics
Physiological modeling, simulation, and control: Methods and tools for identification of physiological systems
Stem cell engineering: Engineering the pluripotent stem cell
: MID-TERM EXAM
Stem cell engineering: Regenerative medicine
0: Bioreactors for stem cell expansion and differentiation
1: Tissue engineering: Strategic directions
2: Tissue engineering: Synthetic biomaterials
3: Signal expression in an engineered tissue
4: Artificial organs
5: Personalized medicine
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Interactive lectures and communication with students
Discussions and group works
Presentations (4-5 students per semester)</td></tr>
<tr><td rowspan="6">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
Recall basic concepts encountered in physiological modeling
Critically discuss the significance of the use of stem cell engineering
Explain tissue engineering principles</td></tr>
</table>

	4. Describe artificial organ development 5. Explain the concept of personalized medicine
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	King, M. R. (2006). Principles of Cellular Engineering: Understanding the Biomolecular Interface. Waltham: Academic Press.
Recommended Literature	Saltzman, W. M. (2004). Tissue engineering: engineering principles for the design of replacement organs and tissues (Vol. 4). New York: Oxford university press.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 502</td><td colspan="3">Course Name: BIOTERRORISM</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td>Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td>Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="3">By taking this course, graduates should gain an understanding and appreciation of issues impacting bioterrorism as a global risk and a serious threat, as well as biodefense – prevention and response to bioterrorism. The topics covered in the course include knowledge about weapons of mass destruction, characteristics and types of pathogens that can be used as biological weapons, the theory behind lab and field techniques used for detection and identification of these pathogens, public health preparedness and response to a bioterrorist event, and, most importantly, how public can be educated about and prepared for bioterrorism.</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The cognitive, affective and behavioral objectives of this course are following:
Educating and raising awareness of the scientists, experts, public health officials and decision makers.
Giving a comprehensive understanding of the history, impact, issues, and future directions associated with biologic threats to human, animal, and plant health.
Enabling graduates to work with biological threat agents in a safe environment.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="3">Terrorism and weapons of mass destruction
Bioterrorism as a global risk and a serious threat
History of bioweapons
Bioterrorism: Types, effectiveness, dissemination routes, and consequences
Types of biological weapons: Pathogens as weapons
Bacterial, viral, and fungal agents and toxins
Trends in bioterrorism: Genetic engineering and biotechnology in improvement of bioweapons
: MID-TERM EXAM
Agro-terrorism
): GMO as bioweapons
: Detection and identification of biological agents
2: Public health preparedness and lab networks
3: Biosafety and biosecurity
4: Partnership of public health, police, and military sectors in response to biological attack
5: Crisis communication in response to biological attack; Bioterrorism and mental health
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="3">Interactive lectures and communication with students
Discussions and group work
Presentations
Guest instructors</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="3">After completion of this course, students should be able to:
1. Argue potential biological threat agents
2. Plan procedures and methods to safely and securely work with these agents in the laboratory</td></tr>
</table>

	3. Summarize public health preparedness, surveillance systems, and federal networks 4. Recognize problems associated with bioterrorism 5. Predict the effect of genetic engineering and biotechnology on the improvement of bioweapons
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Henderson, D. A., & Inglesby, T. V. (2002). Bioterrorism: guidelines for medical and public health management. O. T. Tara Jeanne (Ed.). Chicago: American Medical Association
Recommended Literature	Websites: http://www.bt.cdc.gov (This is an excellent resource for information on bioterrorism select agents and public health emergency preparedness and response). http://www.hopkins-biodefense.org (This is the website for the Center for Civilian Biodefense Strategies).

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 503	**Course Name:** GENETIC TESTING AND COUNSELING		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course starts with the basic principles of population genetics and inheritance patterns in humans as these topics form the basis of the course. Following discussion of prenatal genetics, inherited disorders caused by genetic mutations and chromosomal abnormalities, as well as multifactorial diseases are covered. Course is concluded with the principles of genetic counseling and ethical considerations. During the module, graduates are expected to actively participate and to read and analyze scientific papers on related topics.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing an overview of human genetic concepts and clinical disorders that have a genetic component. ● Teaching graduates to apply their knowledge of the principles of human genetics to a variety of clinical problems. ● Discussing different surveys of many clinical areas including cytogenetics, molecular genetics, biochemical genetics, population genetics, and clinical genetics.		
Course Content (weekly plan)	Basic human and population genetics Inheritance patterns in human; pedigree analysis Prenatal genetics Genetic disorders Genetic basis of inherited disorders Chromosomal disorders Testing for chromosomal disorders **: MID-TERM EXAM** Non-traditional inheritance 0: Testing methodologies 1: Population screening 2: Testing methodologies 3: Principles of multifactorial disorders 4: Genetic counseling 5: Ethical considerations **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Differentiate chromosomal genetic disorders and their testing 2. Apply knowledge of non-traditional inheritance in testing possibilities

	3. Select and employ sophisticated techniques for analyzing population genetics and population screening 4. Critically discuss genetic counseling 5. Apply knowledge of human genetics to clinical problems
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Vogel, F., & Motulsky, A. G. (2013). Vogel and Motulsky's Human Genetics: Problems and Approaches. Berlin: Springer Science & Business Media.
Recommended Literature	Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (2012). Tietz textbook of clinical chemistry and molecular diagnostics. Amsterdam: Elsevier Health Sciences.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 504	**Course Name:** MOLECULAR PRINCIPLES OF VIROLOGY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course provides an introduction to modern virology. As submicroscopic parasites that are more diverse than all the bacterial, plant, and animal kingdoms combined, viruses are an extremely interesting area of study. Through this course, graduates will investigate all aspects of viral genetics, starting with a short history of virology, followed by the function and formation of virus particles, the structure and complexity of virus genomes, virus replication, gene expression, viral infections, and subviral agents, such as satellites, viroids, and prions. Graduates are expected to do an independent research within the area and present their observations during the lectures throughout the semester, as active participation is of the highest importance in this course.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Illustrating the structure of the viral particle. ● Giving an outline of the types of viral replication. ● Providing basic concepts of virus classification. ● Explaining subviral pathogens.		
Course Content (weekly plan)	Week 1: Introducion to the course Week 2: Virology through history Week 3: Virion structure and viral classification according to Baltimore Week 4: DNA and RNA viral replication, retroviral replication Week 5: Workshop on viral detection Week 6: Viral pathogenesis Week 7: Transformation Week 8: MIDTERM EXAM WEEK Week 9: Development and types of vaccines Week 10: Viral Evolution Week 11: Methods used in virology Week 12: Workshop: discovery of novel viruses and their molecular identification Week 13: Human Papilloma virus Week 14: Herpes viruses Week 15: Retroviruses Week 16: FINAL EXAM WEEK		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Recall the basic molecular mechanisms underlying viral infections 2. Revise the molecular structure of viruses 3. Explain the specific connection that forms between viruses and the host cell

	4. Evaluate the molecular basis of infection as well as the molecular structure of some subviral pathogens 5. Define pathogenesis
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Modrow, S., Falke, D., Truyen, U., & Schätzl, H. (2013). Molecular virology. Berlin: Springer.
Recommended Literature	Cann, A. (2011). Principles of molecular virology (Vol. 1). Waltham: Academic Press.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 505</td><td colspan="4">Course Name: PURIFICATION TECHNIQUES OF BIOMOLECULES</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td colspan="2">Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td colspan="2">Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="4">Novel developments in bioscience have dramatically changed the landscape of protein research. In that sense, protein purification methods have become an important aspect in the field of genetics and bioengineering. This course addresses these developments, featuring a wealth of new topics. It covers biochemical separation methods for amino acids and proteins that are in use today, with the main focus on chromatography techniques. Additionally, electorophoretic techniques are discussed in several classes. The course is concluded with concise discussion of carbohydrates, fats and lipids, and nucleic acids. In that way, this course in covering separation and purification of all major classes of natural macromolecules.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Explaining methods which constitute the foundation for purification and analysis of biological molecules, such as nucleic acids and proteins, etc.
Providing an opportunity for graduates to gain practical knowledge of the field.
Comparing conventional and high throughput techniques for purification and analysis of biomolecules.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Identification and purification of amino acids
Protein purification: Initial steps
Chromatography techniques. Size-exclusion chromatography and ion-exchange chromatography
Hydrophobic interaction chromatography. Affinity chromatography
Affinity ligands from chemical and biological combinatorial libraries
Immobilized metal ion affinity chromatography and covalent chromatography
High-resolution reversed phase chromatography
: MID-TERM EXAM
HPLC and GC/MS techniques
): Two-dimensional electrophoresis in proteomics. Blotting techniques
1: Conventional isoelectric focusing in gel slabs and capillaries. Immobilized pH gradients
2: Capillary electrophoretic separations. High-throughput screening techniques in protein purification
3: Purification of carbohydrates
4: Purification of fats and lipids
5: Purification of nucleic acids
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Interactive lectures and communication with students
Discussions and group works
Presentations</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Break down the fundamental theory needed to understand the process of protein purification
2. Apply different methodologies in protein purification</td></tr>
</table>

	3. Conduct protein purification on a molecular level 4. Distinguish various methods of protein purification
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Janson, J. C. (Ed.). (2012). Protein purification: principles, high resolution methods, and applications (Vol. 151). John Wiley & Sons.
Recommended Literature	Dechow, F. J. (1989). Separation and purification techniques in biotechnology. New York: Noyes Publications.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 506	**Course Name:** INTEGRATION OF COMPUTATIONAL AND EXPERIMENTAL BIOLOGY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course offers an insight into the field of computational biology as it relates to classical experimental biology. Since its beginnings, computational biology was useful for molecular biologists of different orientations and therefore is an extremely important contemporary application of classical science. This course gives an overview of computational biology in gene and protein analysis, as well as in analysis of secondary and tertiary structures and in more complex situations, such as in studying metabolic pathways and systems biology. Towards the end of semester, graduates are briefly introduced into phylogenetic analyses. Practical sessions are organized as often as possible and are of the highest importance for achieving success in this field.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to key concepts in computational biology ranging from sequence analysis to structural modeling and systems biology. ● Explaining theoretical foundations of some of the most widely used computational biology techniques. ● Illustrating the principles and methods for pair-wise and multiple sequence analysis, phylogenetic analysis, protein structure modeling and prediction.		
Course Content (weekly plan)	Introduction to the course An overview of computational methods used in molecular, cellular, organismic, and population biology Bioinformatics Practical session: Gene finding and investigation Practical session: Biological sequence analysis and sequence alignment Practical session: RNA folding and genome assembly Practical session: Protein finding and analysis **: MID-TERM EXAM** 2D and 3D modeling of biological molecules. Practical session): Network analysis 1: Practical session: Gene expression analysis and regulatory motifs 2: Practical session: Protein-protein interactions 3: Systems biology. Practical session 4: Simulation of metabolic pathways in silico 5: Phylogenetic analysis. Practical session **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply computational methods used in molecular, cellular, organism and population biology 2. Apply knowledge of bioinformatics, modeling, simulation and network analysis in various research areas 3. Construct and compare phylogenetic trees 4. Use phylogenetic analysis to compare different populations 5. Assess the importance of computational methods in experimental biology
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Arabnia, H. R. (2010). Advances in Computational Biology (Advances in Experimental Medicine and Biology). New York: Springer.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 507	**Course Name:** NUCLEIC ACID AND PROTEIN CHEMISTRY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course offers a novel perspective of two common topics in genetics and bioengineering - nucleic acids and proteins. The first part of the course mainly revolves around DNA and RNA, that is, their chemistry, specialized structures formed within their chains and, finally, characterization methods, which includes equipment for determining nucleic acid size, sequence, melting temperature, orientation, etc. The second part of the course starts with the short study of amino acids, followed by protein chemistry. As an extremely complex area of study, protein chemistry is limited to the discussion of protein composition, higher order structures, biosynthesis, and characterization methods, as these aspects of protein analysis represent protein chemistry in the narrowest sense. During the course, graduates are expected to read scientific articles dealing with either nucleic acid or protein chemistry and present one of them to the class.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Illustrating the chemical basis of nucleic acids and proteins. ● Explaining their functions and interactions at a molecular level. ● Enabling graduates to examine terms covered in the course practically.		
Course Content (weekly plan)	Introduction to nucleic acids: DNA and RNA Basic chemistry of DNA Going further: DNA conformations and chemical interactions Going further: Formation of specialized structures within DNA chain Basic chemistry of RNA. RNA secondary structures Methods of characterization of DNA and RNA Methods of characterization of DNA and RNA **: MID-TERM EXAM** Metabolism of purines and pyrimidines, nucleosides, and nucleotides 0: Amino acids and their metabolism 1: Protein composition 2: Going further: Higher protein structures 3: Going further: Protein biosynthesis 4: Methods of protein characterization 5: Methods of protein characterization **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Critically discuss amino acids, their structure and function 2. Investigate the central dogma of molecular biology on a molecular level

	3. Recall the chemical basics of nucleic acids, their structure and function 4. Analyze practical methods of isolation and characterization of nucleic acids and proteins 5. Apply theoretical and practical knowledge in research
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Berk, A., & Zipursky, S. L. (2000). Molecular cell biology (Vol. 4). New York: WH Freeman.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 508	**Course Name:** GENETIC MARKERS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	In the four decades since the discovery of DNA, molecular genetics and biotechnology have undergone a revolution in the research and application of genetic testing techniques. Researchers can use DNA markers to follow individual traits in different environments and hosts, increasing our understanding of the constitution, diversity, and evolution of genetic material. This course offers valuable new information on this rapidly growing field. The first part of the course is designed to give an overview of different classes of DNA markers, namely STRs, SNPs, and mtDNA markers. The second part of the course discusses practical biotechnological applications of DNA markers for different purposes. Graduates are expected to read scientific articles on a chosen topic and to give short presentations in front of the class. Presentation, as well as active participation, are an important part of overall performance in the course.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to molecular hybridization. ● Explaining theoretical and practical applications of genetic markers. ● Illustrating arbitrarily amplified DNA in ecology and evolution.		
Course Content (weekly plan)	Introduction to DNA markers. Types of markers Genome organization Short tandem repeat DNA markers. RFLP analysis Autosomal and Y-STR testing Single nucleotide polymorphism markers. SNP testing Prediction of physical characteristics using SNPs mtDNA testing **: MID-TERM EXAM** AFLP analysis): Randomly amplified polymorphic DNA (RAPD) analysis : Hybridization-based microsatellite fingerprinting of plants and fungi. Student presentations : Cultivar identification and varietal protection. Student presentations : Molecular markers and forest trees. Student presentations : Arbitrarily amplified DNA in ecology and evolution. Student presentations : Ethical considerations: Informed consent **: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Recall terminology regarding molecular markers 2. Summarize the concept of molecular hybridization

	3. Critically discuss various techniques used for analyzing genetic markers 4. Apply these techniques in research 5. Discuss the importance of arbitrarily amplified DNA in ecology and evolution
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Rademaker, J. L. W., De Bruijn, F. J., Caetano-Anolles, G., & Gresshoff, P. M. (1997). DNA markers: protocols, applications, and overviews. New York: J. Wiley and Sons.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 509</td><td colspan="4">Course Name: BIOMEDICAL TELEMETRY</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td colspan="2">Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td colspan="2">Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="4">This course is designed in a way to offer an insight into biomedical telemetry for bioengineers. It explains the main components of a typical biomedical telemetry system, as well as its technical challenges. It also provides graduates with highly detailed scientific analyses, example applications of biomedical telemetry, technologies for biomedical sensing, and design of biomedical telemetry devices. Graduates are given a chance to see how all components of a telemetric system function within biomedical devices that are used in medicine through occasional practical sessions.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
● Introduction to biomedical telemetry.
● Explaining design considerations of biomedical telemetry devices.
● Demonstrating the connection between biomedical telemetry and biomedicine.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Introduction to biomedical telemetry
Design considerations of biomedical telemetry devices
Sensing principles for biomedical telemetry
Sensing technologies for biomedical telemetry
Power issues in biomedical telemetry
Numerical and experimental techniques for body area electromagnetics
Inductive coupling
: MID-TERM EXAM
Antennas and RF communication
): Intrabody communication
1: Optical biotelemetry
2: Biosensor communication technology and standards
3: Connection between biomedical telemetry and telemedicine
4: Safety issues in biomedical telemetry
5: Clinical applications of body sensor networks
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">● Interactive lectures and communication with students
● Discussions and group works
● Presentations</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Describe the main components of a typical biomedical telemetry system, along with the technical challenges
2. Discuss issues of spectrum regulations, standards, and interoperability
3. Outline body area electromagnetics, inductive coupling, antennas for biomedical telemetry, intra-body communications, non-RF communication links for biomedical telemetry (optical</td></tr>
</table>

	biotelemetry), as well as safety issues, human phantoms, and exposure assessment to high-frequency biotelemetry fields 4. Clarify biosensor network topologies and standards; context-aware sensing and multi-sensor fusion; security and privacy issues in biomedical telemetry; and the connection between biomedical telemetry and telemedicine 5. Assess clinical applications of Body Sensor Networks (BSNs) in addition to selected examples of wearable, implantable, ingestible devices, stimulator and integrated mobile healthcare system paradigms for monitoring and therapeutic intervention
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Nikita, K. S. (Ed.). (2014). Handbook of Biomedical Telemetry. New York: John Wiley & Sons.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 510	**Course Name:** GENETIC DIVERSITY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Throughout this course, graduate students will be introduced to the fundamental aspects of genetic diversity and the importance of its maintenance. All topics required for understanding biodiversity are introduced during the course, which includes DNA polymorphisms, genetic drift, mutations, migrations, and natural selection. Genetic diversity is studied in different situations, such as natural and experimental, as well as isolated populations. Finally, graduates are expected to investigate the concept of population genetic stability.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Teaching the theoretical principles of population genetics. ● Explaining heritable variation in populations. ● Demonstrating the role of natural selection in the maintenance of protein and DNA polymorphisms.		
Course Content (weekly plan)	Week 1: Introduction to the course Week 2: Genomes and their evolution Week 3: Descendant with modification Week 4: The evolution of populations Week 5: The origin of species Week 6: History of Life on Earth Week 7: Workshop **Week 8: MID-TERM EXAM WEEK** Week 9: Phylogeny and the tree of life Week 10: Genetic diversity of monera and protista Week 11: Genetic diversity of plants Week 12: Into to the genetic diversity of Animals Week 13: Diversity of Invertebrates Week 14: Diversity of Vertebrates Week 15: Workshop on genetic diversity **Week 16: FINAL EXAM WEEK**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Calculate statistical parameters frequently used in population studies 2. Recall the theoretical principles of population genetics 3. Recognize genetic processes in natural population systems 4. Analyze genetic processes in experimental population systems 5. Summarize the role of natural selection in the maintenance of protein and DNA polymorphisms

Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2017). Campbell biology. Pearson Education, Incorporated.
Recommended Literature	Altukhov, Y. P. (2006). Intraspecific genetic diversity. Berlin: Springer-Verlag.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 511	**Course Name:** GMO (GENETICALLY MODIFIED ORGANISMS)		
Level: Master	**Year:** I	**Semester:** II, III	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	GMO organisms are among the most controversial topics in the food safety system. However, GMO extend beyond food chain. The course introduction will cover key concepts in the structure and manipulation of DNA and introduce students to the complex issues surrounding GMO development and utilization. Specifically, issues concerning legal, environmental, societal, economic, as well as ethical issues concerning GM food and feed will be discussed in greater depth. Students will also be introduced to the challenges of GMO analysis in the laboratory environment.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Teaching what constitutes GMO and how it is defined. ● Explaining the current state of affairs with regards to GMO in the world. ● Addressing regulatory issues specific to transgenics (authorized vs. unauthorized GMO). ● Demonstrating the difference between cultivation, contained use and authorization to use. ● Addressing health and environmental implications of GMO. ● Providing an outline of the social and economic implications of transgenics (intellectual property rights). ● Illustrating the analytical procedures for the purpose of enforcement (labeling and traceability). ● Explaining issues of coexistence.		
Course Content (weekly plan)	Introduction to GMO (definitions, overview) General biological concepts – rDNA technology (brief overview) Regulatory issues (legislation, labeling, traceability) Placing GMO on the market (safety assessment, environmental interactions) Control and enforcement (role of GMO testing laboratories) Challenges of GMO analysis Environmental implications of GMO and coexistence **: MID-TERM EXAM** GM food vs. organic production): Societal and economic implications of GMOs 1: Bioethics and biosafety 2: GM animals (food, protein factories, model organisms) 3: Benefits and risks associated with biotechnology 4: Health and environment related concerns 5: Ethical issues **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Describe the basics of GMO 2. Memorize regulatory issues 3. Properly address health issues 4. Illustrate the process of rDNA technology 5. Debate the advantages and disadvantages of GMO
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Halford, N. (Ed.). (2006). Plant biotechnology: Current and future applications of genetically modified crops. New York: John Wiley & Sons.
Recommended Literature	Acquaah, G. (2009). Principles of plant genetics and breeding. New York: John Wiley & Sons. Stewart Jr, C. N. (Ed.). (2012). Plant biotechnology and genetics: principles, techniques and applications. New York: John Wiley & Sons. Clark, D. P., & Pazdernik, N. J. (2015). Biotechnology: applying the genetic revolution. Amsterdam: Newnes. Žel, J., Milavec, M., Morisset, D., Plan, D., Van den Eede, G., & Gruden, K. (2012). How to reliably test for GMOs (pp. 1-95). New York City: Springer US.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 512	**Course Name:** MICROBIAL GENETICS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course focuses on how bacteria and bacteriophages arrange and rearrange their genetic material through mutation, evolution, and genetic exchange to take optimal advantage of their environment. The course is divided into three sections, namely DNA metabolism, genetic response, and genetic exchange. The first part addresses DNA replication, repair, and recombination in microorganisms. The second part is devoted to the interaction of microbes with their environment, which includes stress shock, and the final part of the course offers graduates the latest information on classic exchange mechanisms, such as transformation and conjugation. Through modern approach to the classical topic of microbial genetics, graduates are expected to connect the basic concepts in genetics they got familiar with during their undergraduate studies with the shape and metabolism of microorganisms and to understand specificities of the genetics of microbes as it relates to the genetics of higher organisms. Graduates are also expected to perform independent research during the course and to understand practical implications of the course on their own.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to the foundation principles and concepts of modern microbial genetics. ● Stimulating active inquiry in a laboratory environment. ● Giving an outline of the behavior of genetic material within bacteria and bacteriophage. ● Explaining DNA metabolism, genetic response and genetic exchange in connection to microorganisms.		
Course Content (weekly plan)	Introduction to the course Bacterial Morphology and Structure Bacterial Genome Plasmids Phenotypic tests for the determination of antibiotic resistance and most dangerous resistant bacteria Molecular basis of antibiotic resistance and resistance genes Molecular Diagnostics in the clinical laboratory **MID-TERM EXAM** Biofilms, quorum sensing and two component signal transduction pathway : Biofilm calculations : Agrobacterium genetics : Molecular structure of viruses : Viral nucleic acid replication : Subviral pathogens : Case study **: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communications with students ● Tutorials		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Define gene expression and its regulation 2. Clarify single-stranded DNA phages 3. Describe the genetic tools for dissecting motility and development of *Myxococcus xanthus* 4. Discuss the molecular mechanism of quorum sensing 5. Explain the transduction in Gram-negative bacteria
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Willey, J. M. (2008). Prescott, Harley, and Klein's Microbiology-7th international ed. /Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. New York: McGraw-Hill Higher Education.
Recommended Literature	Streips, U. N., &Yasbin, R. E. (Eds.). (2002). Modern microbial genetics (Vol. 344). Hoboken: Wiley-Liss.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 513	**Course Name:** ADVANCED TOPICS IN BIOENGINEERING		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course offers graduates a unique opportunity to get familiar with practical applications of bioengineering in different areas of science and industry. As a modern field of science which is all about practical applications, it is extremely important for our graduates to be aware of importance of bioengineering. During the course, applications of bioengineering in medicine, biosensors, molecular and tissue engineering, computer science, and nanotechnology are covered. At the end of semester, graduates are expected to identify the topic that suits them best and to read articles, discuss them, and present in front of the class. One of important objectives of this course is to present career opportunities in bioengineering to those taking the course.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Discussing the molecular and cellular basis of life from an engineering perspective. ● Illustrating crucial molecular parameters involved in cellular events. ● Explaining cell-function relationship and cell-biomaterials relationship. ● Providing basic concepts of thermodynamics and kinetics of protein/ligand binding, with an emphasis on experimental techniques for measuring molecular parameters, such as equilibrium affinities, kinetic rate constants, and diffusion coefficients.		
Course Content (weekly plan)	Introduction to bioengineering: Basic concepts Biochemical molecular engineering Biomedical signals and sensors Biotransport Bioengineering systems and control Tissue engineering Biomechanics **: MID-TERM EXAM** Advanced molecular bioengineering 0: Computational bioengineering 1: Bioengineering and nanotechnology 2: Engineering materials for biomedical applications 3: Systems bioengineering 4: Article analysis and discussion 5: Student presentations **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communications with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Break down the fundamental topics in bioengineering 2. Outline advanced topics in bioengineering 3. Apply bioengineering skills and methodologies in thesis preparation 4. Measure and manipulate molecular parameters experimentally 5. Explore and criticize existing and emerging technologies that exploit today's knowledge of molecular and cell biology
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Chien, S., & Fung, Y. C. (2008). An introductory text to bioengineering (Vol. 4). Singapore: World Scientific.
Recommended Literature	Deen, W. M. (1998). Analysis of Transport Phenomena, Topics in Chemical Engineering (Vol. 3). New York: Oxford University Press.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 514	**Course Name:** ADVANCED TOPICS IN BIOINFORMATICS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is advanced-level bioinformatics for professionals in genetics and bioengineering. Apart from concise analysis of DNA and RNA sequences, the majority of the course is based on protein sequence analysis, which includes evolution and phylogenetic studies based on protein sequences, building protein interaction networks, and determining protein function and domains from its primary structure. Kernel-based methods and hidden Markov models of statistical data analysis are also covered during the course. This course is useful for those who are intending to pursue career in bioinformatics, as well as for those who are using bioinformatics as a tool for data analysis.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing basic concepts of advanced bioinformatics topics. ● Illustrating the practical application of those concepts. ● Encouraging graduates to apply their knowledge in research.		
Course Content (weekly plan)	Basic concepts in bioinformatics DNA and RNA sequences: Finding the gene of interest and sequence alignment Comparative genome analysis Next-generation sequencing *In silico* analysis of proteins: Finding amino acid sequence and sequence alignment Protein folding problems. Prediction of secondary and tertiary structure. Multiple structural alignment and protein docking **: MID-TERM EXAM** Functional classification of proteins 0: Human genome annotation 1: Phylogenetic analyses: UPGMA and NJ methods 2: Evolution studies by using protein sequence alignment 3: Statistical modeling of biological data: Kernel-based methods and hidden Markov models 4: Data integration 5: Prediction and mining of genetic networks and protein interaction networks **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communications with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Illustrate state-of-the-art methods to tackle important biological problems 2. Recognize recent developments in the field of bioinformatics 3. Initiate research in this area 4. Recognize current challenges in bioinformatics 5. Apply knowledge gained thorough this course in other research fields

Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Orengo, C., Jones, D. T., & Thornton, J. M. (2003). Bioinformatics: genes, proteins and computers. London: Garland Science.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 515</td><td colspan="3">Course Name: CANCER BIOLOGY</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td>Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td>Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="3">This course gives graduate students an advanced level of knowledge in cancer biology by explaining cancer formation and spreading from both molecular and cellular points of view. The first part of the course introduces concepts of cancer, tumor, oncogenes, tumor suppressor genes, and the steps in carcinogenesis. Following this introductory part, the course introduces mutations and defects in DNA that might lead to cancer, as well as the most likely points in cell cycle in which cancer usually develops. The final topics thought in the course are related to cancer diagnosis and treatments. During the course, graduates are expected to read high quality scientific articles and give a short presentation in front of the class in order to show their understanding of the topic.</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The cognitive, affective and behavioral objectives of this course are following:
Introduction to the fundamental concepts of cancer development.
Explaining the molecular and genetic basis of cancer.
Teaching about prevention, detection and treatment of cancer.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="3">Genetic, cellular, and molecular concepts of cancer development. Techniques. Cancer principles
Carcinogens. Tumor viruses
Multi-step carcinogenesis. Angiogenesis
Invasion and metastasis. Oncogenes
Growth factors and receptors. Tumor suppressor genes
CDK regulation by cyclin binding/phosphorylation. CDK regulation by CDK inhibitors/RB and E2Fs
Cell death signaling and cancer. Cellular signaling and cancer
: MID-TERM EXAM
Cell immortalization and tumorigenesis
): DNA repair defects can lead to cancers
: Cell transformation requires multiple genes
2: Prevention, early detection, and genetic testing for cancer risk
3: Surgery, radiation therapy, and chemotherapy
4: The rational of treatment of cancer. Tumor immunology and immunotherapy
5: Yeast and fruit fly models of human cancer. Mouse model of human cancer. Delivery of medicine to tumors
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="3">Interactive lectures and communication with students
Discussions and group works
Presentations</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="3">After completion of this course, students should be able to:
1. Explain chromosome instability
2. Demonstrate the properties of cancer cells and tissues
3. Interpret the role of viruses in cancer</td></tr>
</table>

	4. Review the concept of tumor suppressor genes/oncogenes 5. Clarify DNA damaging agents/DNA repair
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Weinberg, R. (2013). The biology of cancer. London: Garland Science.
Recommended Literature	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (1997). Molecular Biology of the Cell. London: Garland Science

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 516	**Course Name:** SYSTEMS NEUROGENETICS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Understanding the relationship between genes and behavior will be the primary goal of this course. Graduates will build on their knowledge of classic and contemporary genetics tools that are utilized by researchers to study behaviors such as courtship, addiction, memory, sleep, and aggressive behavior. The course will focus on investigating model systems (fruit flies, nematode, zebrafish, and mice) amenable to genetic manipulation through weekly readings, analysis, and discussion of relevant literature. The course will also discuss the relationship among genetics, development, and neural circuitry. Through analyzing and presenting primary scientific articles, graduates will communicate their understanding of neurogenetics. Topics of discussion will be current literatures related to genetic effects on neural functions, including: (1) mental illness, (2) neurodegenerative diseases, (3) various behaviors, and (4) learning and memory.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Illustrating the role of genetics in the development of the nerve system. ● Explaining the link between genetics and behavior. ● Introduction to neurogenetics.		
Course Content (weekly plan)	Overview of the course: Introduction Introduction to basic neuroscience (in relation to genetics) (Genetics and) neural development (Genetics and) neural functions (Genetics in) learning and memory Flies, nematodes, and vertebrate models as neurogenetic tools Neurogenetics and behavior: Addiction and sleep **: MID-TERM EXAM** Genetics and neurodegenerative disease: Schizophrenia): Genetics and neurodegenerative disease: Alzheimer's disease 1: Genetics and neurodegenerative disease: ALS 2: Genetics and neurodegenerative disease: Parkinson's and Huntington's diseases 3: Neurogenomics: Techniques and advances 4: Neuroimaging techniques 5: Neurogenetics and molecular biology of human brain tumors and migraine **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Analyze various neurodegenerative diseases 2. Read articles and critically analyze them

	3. Revise various techniques used in neurogenetics 4. Point out the role of genetics in the development of the nervous system 5. Relate genetics and behavior
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Bear, M. F., Connors, B. W., & Paradiso, M. A. (2006). Neuroscience: Exploring the Brain, 3rd ed. Philadelphia: Lippincott Williams & Wilkins.
Recommended Literature	Warner, T. T., & Hammans, S. R. (2008). Practical guide to neurogenetics. Amsterdam: Elsevier Health Sciences. Additional published scientific literature

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 517</td><td colspan="4">Course Name: DEVELOPMENTAL BIOLOGY</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td colspan="2">Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td colspan="2">Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="4">As one of the fastest growing and most exciting fields in biology, developmental biology creates a framework that integrates molecular biology, physiology, cell biology, anatomy, cancer research, neurobiology, immunology, ecology, and evolutionary biology. Therefore, the study of development has become essential for understanding any area of biology. Our MSc students are offered a course which studies organism development from different points of view, including those of molecular biology, cytology, embryology, and developmental genetics, and by using model organisms from different taxonomic groups. The course is giving an overview of organ and tissue development, stem cells, growth, aging, metamorphosis, and regeneration. An emphasis is put on evolution as is relates to different developmental pathways in different taxonomic categories.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Explaining the basics of gametogenesis and early development.
Explaining developmental genetics.
Illustrating the development of organs.
Providing basic concepts of growth, aging and cancer.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">How development works
Gametogenesis and early development
Approaches to development: Developmental genetics
Approaches to development: Experimental embryology
Approaches to development: Cell and molecular biology techniques
Major model organisms
Techniques for studying organogenesis and postnatal development
: MID-TERM EXAM
Development of nervous system
0: Development of mesodermal organs
1: Development of endodermal organs
2: Drosophila imaginal discs. Tissue organization and stem cells
3: Growth, aging, and cancer
5: Regeneration of missing parts
4: Evolution and development
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Interactive lectures and communication with students
Discussions and group works
Presentations</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Summarize the process of gametogenesis
2. Explain the early developmental stages</td></tr>
</table>

	3. Clarify organogenesis 4. Review growth, aging and regeneration topics 5. Illustrate techniques used in developmental biology
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Slack, J. M. (2009). Essential developmental biology. Hoboken: John Wiley & Sons.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 518</td><td colspan="4">Course Name: PHARMACOGENOMICS AND GENE THERAPY</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td colspan="2">Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week: 3+0</td><td colspan="2">Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="4">The first part of this course aims at advancing graduates' knowledge of the genetic basis for variable drug response, which is actually the basis of pharmacogenomics. Through the study of genomes, phenotypes, ethnicity, and drugs, it is possible to identify clinically significant variations between individuals in order to predict the right choice and dose of medications, which is usually referred to as "personalized medicine". The second part of the course covers gene therapy, that is, individual therapeutic approach based on delivery of nucleic acids into patient's body. Types of nucleic acids, delivery methods, photodynamic therapy, and clinical applications are covered.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Familiarizing graduates with modern approaches.
Showing them how genetic material is used in personalized medicine.
Discussing the advantages and drawbacks of pharmacogenomics.
Providing basic concepts of gene therapy.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Introduction to the pharmacology aspect of pharmacogenomics
Choosing phenotypes for pharmacogenomic studies
Introduction to the genomics of pharmacogenomics
Statistical considerations in pharmacogenomics
Methods for pharmacogenomic discovery: Classical genetic techniques
Pharmacogenomics in facilitating drug discovery
The role of ethnicity in pharmacogenomics
: MID-TERM EXAM
Economic and ethical issues in pharmacogenomics
): Role of pharmacogenomics in clinical practice
: Clinical implementation of pharmacogenomics
2: Introduction to gene therapy
3: Therapeutic nucleic acids
4: Methods for gene delivery. Photodynamic therapy
5: Clinical applications of gene therapy
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Interactive lectures and communication with students
Discussions and group works
Presentations</td></tr>
<tr><td rowspan="6">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Explain the significance of pharmacogenomics in clinical practice
2. Summarize the basics of gene therapy
3. Recall basic terminology in pharmacogenomics
4. Investigate the application of genetic material in personalized medicine</td></tr>
</table>

	5. Calculate statistical parameters used in pharmacogenomics
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Altman, R. B., Flockhart, D., & Goldstein D. B. (2012). Principles of Pharmacogenetics and Pharmacogenomics, 1st ed. Cambridge: Cambridge University Press.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	21
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

<table>
<tr><td>Course Code: GBE 519</td><td colspan="4">Course Name: OMICS TECHNOLOGY</td></tr>
<tr><td>Level: Master</td><td>Year: I</td><td colspan="2">Semester: I, II</td><td>ECTS Credits: 6</td></tr>
<tr><td>Status: Elective</td><td colspan="2">Hours/Week:3+0</td><td colspan="2">Total Hours: 45+0</td></tr>
<tr><td>Course Description</td><td colspan="4">Modern-age biology has been transformed by various high-throughput technologies (genomics, proteomics, metabolomics, etc.), which in turn have led to a large number of massive databases and software analysis packages. This course aims to give information about each omics technology. Graduates are expected to grasp the basic ideas of all those widely applicable technologies, to read and discuss scientific articles, and to give short presentations in front of the class in order to earn points for the final grade.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
● Introduction to omics technologies.
● Explaining their applications on a deeper level.
● Explaining paper analysis and paper presentation.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Introduction to omics technologies
Genomics
Comparative genomics
Functional genomics
Epigenomics
Personal genomics
Structural genomics
: MID-TERM EXAM
Pharmacogenomics
): Transcriptomics
1: Proteomics
2: Metabolomics
3: Nutrigenetics
4: Article analysis and discussion
5: Student presentations
6: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">● Interactive lectures and communication with students
● Discussions and group works
● Presentations</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
1. Define omics technologies and describe their applications
2. Differentiate among genomics, comparative genomics, functional genomics, personal genomics, as well as structural genomics
3. Recall basic concepts of epigenomics
4. Explain metabolomics and nutrigenetics
5. Clarify pharmacogenomics, proteomics and transcriptomics</td></tr>
</table>

Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Benkeblia, N. (2012). OMICs Technologies: Tools for Food Science, 1st ed. Boca Raton: CRC Press
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 520	**Course Name:** MOLECULAR ANTHROPOLOGY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is introducing graduates to the concept of human and primate evolution through the study of genetic data, that is, DNA and proteins. Introductory lectures are dealing with the basic concepts in evolution, such as drift and selection, as well as with differences in genome structure and organization among primate taxa. The rest of the course is mainly based upon the study of primates, differences between them, and how they relate to human species on molecular level. The course is concluded with concise study of human population: its evolution, differentiation, and dispersal throughout the world.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing basic concepts of molecular anthropology. ● Explaining the evolution of primates in the molecular sense. ● Teaching the molecular systematic of the primates.		
Course Content (weekly plan)	What is molecular anthropology The human genome and its diversity. Discovering and assaying genome diversity Patterns and functional significance of differences in genomes across different primate taxa Genetic diversity: Drift, neutral theory, and molecular clock Genetic diversity: Selection Homology at the genetic level The fossil record of primate phylogeny **: MID-TERM EXAM** Relationships among and between major groups based mainly on molecular data): Investigating the adaptive significance of patterns of molecular diversity within and between primate taxa : Molecular primatology: Examining kinship behavior, dispersal patterns, and social organization in wild primates using genetic data 2: Conservation genetics: Applying molecular techniques to primate conservation biology 3: The origin and dispersal patterns of human populations using genetic data 4: Peopling of the Old World. Peopling of the Pacific and expansion into the New World 5: Health implications: Genetic and infectious diseases **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations ● Discussion and presentation of authentic forensic cases		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Recall basic terminology in molecular anthropology 2. Explain evolution rates in primates 3. Clarify the molecular clock concept

	4. Describe primate phyologeny 5. Illustrate the comparative aspects of DNA in higher primates
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Goodman, M. (Ed.). (2012). Molecular anthropology: Genes and proteins in the evolutionary ascent of the primates (Vol. 62). Berlin: Springer Science & Business Media.
Recommended Literature	Rice, P. C., & Moloney, N. (2008). Biological Anthropology and Prehistory: Exploring Our Human Ancestry. London: Routledge. Mastana, S. (2007). Molecular Anthropology: Population and forensic genetic applications. Anthropol, 3, 373-83. Destro-Bisol, G., Jobling, M. A., Rocha, J., Novembre, J., Richards, M. B., Mulligan, C., & Manni, F. (2010). Molecular anthropology in the genomic era. J. Anthropol. Sci, 88, 93-112

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 521	**Course Name:** STEM CELLS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This MSc course combines classical approach to cell culture with modern investigation of stem cells for therapeutic and research purposes. It is giving an overview of biology of stem cells and their mode of functioning, but it also contains basic guidelines for laboratory work involving stem cells. The second part of the course is discussing adult and differentiated stem cells, thus showing possible applications of stem cell research. As an unavoidable part of the course, ethics and legal regulations concerning stem cells are briefly discussed.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Explaining the basics of stem cell biology. ● Illustrating the use of stem cells. ● Describing different methodologies and applications of stem cells.		
Course Content (weekly plan)	Introduction to the course: Why stem cell research? Stem cells. Stemness: Definitions, criteria, and standards Basic biology and mechanisms of stem cells Stem cell culture: Sterile techniques, cell growth, cell culture media, and passaging Epigenetics Embryonic stem cells A new path: Induced pluripotent stem cells **: MID-TERM EXAM** Adult stem cells and stem cell niches): Hematopoietic stem cells : Neural stem cells 2: Muscle and cardiac stem cells 3: Cancer stem cells 4: Therapeutic prospects and tissue engineering. Animal models of regeneration 5: Regulations, politics, and ethics in stem cell research **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Interpret basic concepts about stem cells 2. Clarify pluripotent cells 3. Generalize the application of stem cells in various fields 4. Summarize used methodologies 5. Outline regulation issues and ethics regarding stem cell research
Prerequisite Course(s)	None

(if any)	
Language of Instruction	English
Mandatory Literature	Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & West, M. (Eds.). (2005). Essentials of stem cell biology. Waltham: Academic Press.
Recommended Literature	None

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 522	**Course Name:** ETHICS AND PUBLIC POLICY IN BIOENGINEERING		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is organized as a general overview of possible ethical issues and legal regulations related to bioengineering and new biotechnologies that are interesting for both professional community and public. The introductory part of the course is consisted of short explanation of ethics – its definition, classification, and how it relates to modern science. The rest of the course is mainly consisted of real-life examples of situations in which bioengineering caused contrasting views to arise and was a subject of public debates. Probably the most well-known case is that of HeLa cell lines, which is the first topic discussed in this module. At the end of semester, students are organizing a debate in which they are discussing the need for GM crops in Africa. In that way, students will show their understanding of ethics in bioengineering, but will also be given a chance to express their personal opinions on this current topic.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to ethics. ● Giving an outline of the history of bioethics. ● Explaining the steps required to perform research in an ethical way. ● Defining the risks of genetic engineering.		
Course Content (weekly plan)	Introduction to the course Ethics: Definition and basic principles Bioengineering and questions of philosophical, social, and practical import Bioethics and its history: The HeLa cell line case and the issue of the human subjects of biotechnological research Weighing competing values: Informed consent, profit, and the public good Advocates and critics of the new bioengineering applications Defining the risks of genetic engineering **: MID-TERM EXAM** The growth of an industry: Patenting life and university-industry relations 0: Agricultural biotechnology: The Golden Rice case; food safety and environmental issues 1: Gene therapy: Advantages and possible drawbacks 2: Genetically modified organisms: Pros and cons 3: Reproductive technologies: From *in vitro* fertilization to designer babies 4: Cloning and stem cells 5: Student debate: Does Africa need GM crops? **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Recall basic terminology regarding ethics and bioethics 2. Memorize the history of bioethics 3. Apply steps necessary to conduct scientific research in an ethical way 4. Define the risks of genetic engineering 5. Critically discuss the advantages and possible drawbacks of gene therapy
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Gehring, V. V. (2003). Genetic Prospects: Essays on biotechnology, ethics, and public policy. Lanham: Rowman & Littlefield.
Recommended Literature	None

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 523	**Course Name:** TECHNIQUES IN MOLECULAR BIOLOGY		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is organized as an advanced-level explanation of molecular biology techniques for professionals in genetics and bioengineering. Apart from basic techniques, such as DNA, RNA, and protein isolation, spectrophotometry, electrophoresis, and PCR, advanced topics in molecular biology are introduced as well. Some of those topics are: primer design, two-dimensional electrophoresis, blotting techniques, in situ hybridization, etc. Occasional practical sessions are organized in order to remind graduates on the basic postulates of laboratory work in molecular biology.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Illustrating different methods of isolation of nucleic acids and proteins. ● Revising the advantages and drawbacks of different quantification methods. ● Enabling graduates to perform analysis of different biomolecules practically. ● Introduction to primer design. ● Demonstrating how to prepare radioactively-labeled nucleic acid probes and how to perform blotting techniques. ● Enabling graduates to perform bacterial transformation in a safe environment. ● Introduction to NGS.		
Course Content (weekly plan)	Introduction to the course DNA and RNA isolation methods Protein isolation methods UV/vis spectrophotometry Vertical and horizontal electrophoresis Two-dimensional electrophoresis Thermal cycling (PCR and qPCR) **8: MID-TERM EXAM** Primer design 9: Preparation of radiolabeled DNA and RNA probes 1: Southern, Northern, and Western blotting 2: *In situ* hybridization 3: Restriction digestion and ligation of DNA fragments 4: Bacterial transformation: Plasmid isolation, vectors, and plasmid insertion 5: Next-generation sequencing **6: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Use different isolation methods of nucleic acids and proteins.

	2. Conduct several types of quantification methods. 3. Perform PCR. 4. Prepare radioactively-labeled nucleic acid probes. 5. Perform different blotting techniques. 6. Conduct bacterial transformation in a safe environment. 7. Recall the basic terms about NGS.
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Gadella, T. W. (Ed.). (2011). FRET and FLIM techniques (Vol. 33). Amsterdam: Elsevier.
Recommended Literature	Wilson, K., & Walker, J. (Eds.). (2010). Principles and techniques of biochemistry and molecular biology. Cambridge: Cambridge university press.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 524	**Course Name:** NANOTECHNOLOGY AND NANOSENSORS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course will introduce students to the rapidly developing field of nanoscience with special focus on their electronic properties, basic phenomena and ideas of nanoscience and nanosensors, physics and		

<table>
<tr><td></td><td colspan="4">technology of nanoengineered materials and devices, semiconductor nanostructures, nanotubes and nanowires, molecular electronics, and applications in nanoelectronics, quantum computing, nanobiology and nanomedicine. Special lectures about nanosensors and their application are given at the end of the semester.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Giving an outline of basic concepts of nanostructures.
Introduction to the rapidly developing field of nanoscience with special focus on their electronic properties.
Explaining fundamental aspects of the electronic properties of these materials.
Teaching fabrication processes and applications.
Illustrating nanosensors in practice.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Introduction to the basic phenomena and ideas of nanoscience and nanotechnology
An overview of basic concepts of nanostructures
A self-contained introduction to quantum mechanics
Introduction to science necessary to understand the matter at the “nano” scale
A selective survey of nanostructured materials
Properties and application of quantum dots and quantum wells
The tools for characterization of nanostructures
: MID-TERM EXAM WEEK
Smart materials based on nanostructures; examples of existing applications and potential new ones
0: Applications in (nano)electronics, (quantum) computing, (nano)biology, and (nano)medicine
1: Introduction to basic principles of sensors
2: Introduction to nanosensors
3: Nanosensor division
4: Application of nanosensors
5: Practical examples of nanosensors
6: FINAL EXAM WEEK</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Interactive lectures and communication with students
Discussions and group work
Presentations</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
Recognize state of the art developments in the field of nanotechnology
Compare common themes across nanotechnology
Distinguish various individual nanotech implementations
Solve the quantum confinement equations which lead to reduced dimensionality
Analyze various modern technologies used in nanotechnology to grow bulk crystals, thin films, and nanoscale quantum structures, including the epitaxy of semiconductors
Argue optical and electronic properties of semiconductor nanostructures such as quantum wells and quantum dots</td></tr>
</table>

	7. Manipulate and calculate physical parameters related to nanotechnology, such as mean free paths and phase coherence lengths 8. Explain the effect of the reduced dimensionality on the electronic charge transport
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Lindsay, S. M. (2009). *Introduction to Nanoscience. Pap/Cdr edition.* Oxford, UK: Oxford University Press
Recommended Literature	Ratner M. & Ratner D. (2002). *Nanotechnology, 1st ed.* Upper Saddle River, NJ, USA: Prentice Hall Koch C. (2007). *Nanostructured Materials, 2nd ed.* Norwich, NY, USA: Noyes Publications Mitin, V., Kochelap, A.V., & Stroscio, M.A. (2008). *Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications, 1st ed.* Cambridge, UK: Cambridge University Press

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 525	**Course Name:** LABORATORY QUALITY MANAGEMENT SYSTEMS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course will provide the students with knowledge and understanding of quality systems and the accreditation processes undertaken in laboratories. The course will focus on skills and abilities to evaluate the quality systems in laboratory and how to implement improvement processes. The ISO 9001, ISO 17020, ISO 17025, ISO 15189 standards will be examined and approaches to the conduct of		

<table>
<tr><td></td><td colspan="4">internal audits, establishing error logs, training records and accreditation documentation etc. will be explored. Student will acquire knowledge on writing procedures according to International standards, conducting of internal audits, equipment and personnel management, etc. Student will acquire knowledge on writing procedures according to International standards, conducting of internal audits, equipment and personnel management, etc.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">The cognitive, affective and behavioral objectives of this course are following:
Provide students with an understanding of quality and its role in the organization together with techniques
Enable students to make a significant contribution to an organization’s strategic vision for success.
Provide students with knowledge for effective implementation of procedures of process in laboratory.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td colspan="4">Introduction to quality management
Introduction to quality management
International standards terms and definitions
International standards terms and definitions
General requirements
Structural requirements
Resource requirements
: MID-TERM EXAM WEEK
Process requirements
): Process requirements
1: Management system documentation
2: Management system documentation
3: Management review
4: Management review
5: Independence requirements – Working procedures
6: FINAL EXAM WEEK</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">Interactive lectures and communication with students
Discussions and group work
Presentations</td></tr>
<tr><td rowspan="6">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>30 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>0 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course, students should be able to:
Have understanding of scientific concepts and procedures according to quality management,
Have understanding of application specific International standards and meeting all the requirements;
Develop management skills related to inventory, personnel and operations in quality management system</td></tr>
<tr><td>Prerequisite Course(s)</td><td colspan="4">None</td></tr>
</table>

Language of Instruction	English
Mandatory Literature	1. L Barrie G. Dale, Ton van der Wiele, Jos van Iwaarden , Managing Quality, 5th Edition, BlackWell Publishing, 2007 2. International Standard ISO/IEC 17020:2012 3. International Standard ISO 9001:2008 4. 2015 Handbook of International Quality Control, Auditing, Review, Other Assurance, and Related Services Pronouncements
Recommended Literature	None

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	15	2	30
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	20	20
Assignment / Homework / Project	1	21	21
Seminar / Presentation	1	20	20
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 526	**Course Name:** BIOMEDICAL DATA AND ANALYSIS		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week**: 3+0		**Total Hours:** 45+0
Course Description	This course will introduce students to medical and biomedical engineering concepts. The focuses are on how signal analysis can clarify the understanding of biomedical signal interpretation and diagnosis. Topics include EEGs, ECGs, EMGs, respiratory and blood pressure (how they are generated and measured), biosignals as random processes, spectral analysis, wavelets, time-frequency functions, and signal processing for pattern recognition.		
Course Objectives	• To make students familiar with peculiarities of biomedical data and signals;		

<table>
<tr><td></td><td>
• To learn about the origin, nature and specific characteristics of commonly encountered biomedical data and signals;
• To learn about the concepts of random variables and random processes in relation to biomedical data and signals;
• To get insight into theoretical background of various methods for processing of deterministic and stochastic data and signals;
• To get practical experience in applying various methods for extraction of information from selected types of biomedical data and signals useful for their analysis and classification.
</td></tr>
<tr><td>Course Content</td><td>
Week 1: Sources and types of biomedical data and signals.
Week 2: Common biomedical signals and their characteristics: ECG, EMG, EEG, HRV, blood flow and pressure, oxygenation, respiratory signals, nerve conduction, gait/posture.
Week 3: Random variable, probability functions, random processes, moment functions.
Week 4: Parameter estimation based on time-limited random signals.
Week 5: Stationarity and nonstationary of random signals, assessment of stationarity.
Week 6: Power spectral density and its estimates based on non-parametric (Fourier-based methods) and parametric approaches, data windowing.
Week 7: Convolution, correlation and coherence.
Week 8: MIDTERM EXAM
Week 9: Parametric modelling of random processes and linear prediction.
Week 10: Noise and artefacts in biomedical signals and their removal (linear frequency filtering, event detection, optimal Wiener filtering and adaptive filtering, cestrum and homomorphic deconvolution).
Week 11: Time-frequency and time-scale analysis (short-time Fourier and wavelet transforms).
Week 12: Methods for multidimensional regression analysis to discover dependencies in biomedical data (linear basis function models – maximum likelihood and least squares, Bayesian regression, logistic regression, non-linear regression).
Week 13: Algorithms of feature selection and extraction for biomedical data and signals – biomedical data mining methods as principal component analysis, independent component analysis, factor analysis, correspondence analysis.
Week 14: Medical decision-making approaches (pattern recognition and classification methods – linear models for classification, neural networks, kernel methods, classification trees and forests, clustering, expert systems, genetic algorithms).
Week 15: Recap
Week 16: FINAL EXAM
</td></tr>
<tr><td>Teaching Methods Description</td><td>
● Interactive lectures and communications with students ● Tutorials
</td></tr>
<tr><td>Assessment Methods Description (%)</td><td>
<table>
<tr><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>0 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>30 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
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</td></tr>
<tr><td>Learning Outcomes</td><td>
The students will be able to:
1. Explain the theoretical background of mathematical methods used for processing of biomedical and other random data and signals.
2. Describe and explain the specific characteristics of common types of biomedical data and signals (ECG, EMG, EEG, HRV, blood flow and pressure, oxygenation, respiratory signals, nerve conduction, gait/posture etc.).
3. Understand the concept of a statistical estimate of an unknown value of parameter.
4. Apply various methods in time, frequency, and time-frequency domains to extract clinically relevant information from typical biomedical signals.
5. Critically evaluate and present the results of data and signal processing.
6. Select an appropriate tool for data and signal processing (and justify the selection) based on data and/or signal characteristics and the specific goal of processing.
</td></tr>
</table>

	7. State principles of medical decision-making systems, analyze ways to apply them to particular medical problems and specify requirements to the abovementioned systems. 8. Know how to use mathematical models for biomedical data and signal processing, analysis, and classification 9. Discuss practical data and signal processing problems at hand with peers and work individually or as a member of a team to solve the problem.
Prerequisite Courses	None
Language of Instruction	English
Mandatory Literature	Raden, J. F. (2010). *Handbook of Modern Sensors, Physics, Designs and Applications*. New York, NY, USA: Springer-Verlag
Recommended Literature	Enderle, J. & Bronzino, J. (2011). *Introduction to Biomedical Engineering*, 3rd ed. Burlington, MA, USA: Elsevier Academic Press Webster, J. G. & Eren, H. (2014). *Measurement, Instrumentation, and Sensors Handbook, 2nd ed.* Boca Raton, FL, USA: CRC Press

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	20	20
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	1	20	20
Seminar / Presentation	1	30	30
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 527	**Course Name:** BIOMEDICAL INSTRUMENTATION AND MEASUREMENT		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week**: 3+0		**Total Hours:** 45+0
Course Description	This course will introduce the students to basic biomedical engineering technology so that they can understand and evaluate (and perhaps design) systems and devices that can measure, test, and acquire biological information. The course will encompass systems of human physiology as well as the bio-		

	signals they generate. The focus will also be on biosensors, transducers, bio-electrodes used for acquisition, and amplifiers for measuring bio-potentials. Some bioethics will be discussed as well. Introduction to fundamentals of biomedical instrumentation, biomedical sensors and physiological transducers, biomedical recorders, patient monitoring systems, arrhythmia and ambulatory monitoring instruments, cardiac pacemakers, cardiac defibrillators, MRI and CT systems are the topics covered within the course.
Course Objectives	• To introduce students to the principles, applications and design of biomedical instruments and systems used in diagnostics and treatment of patients. • To provide knowledge about biomedical instrumentation systems including different sensors of physiological quantities, signal acquisition, conditioning, processing and display modalities, including regulation and safety of the devices.
Course Content	Week 1: Introduction to biomedical instrumentation: objectives and concepts; generalized medical instrumentation systems (classification, static and dynamic characteristics, design criteria, development process, BMI constrains). Week 2: Biopotentials origins and processing: electrical activity of excitable cells; volume conductor characteristics; basic electrophysiology; sources of biopotentials (ECG, EEG, EMG, ERG, EOG, MEG etc.). Week 3: Biopotential amplifiers. Week 4: Biopotential electrodes: electrode – electrolyte interface; polarization; electrode modelling and circuit models; electrode – skin interface; artefacts and noise; recording electrodes (body surface electrodes, implantable electrodes, icroelectrodes); stimulation electrodes (body surface electrodes, implantable electrodes). Week 5: Sensors and transducers in BME; active and passive sensors; sensors and transducers for different physical quantities, applied to BME. Week 6: Sensors and transducers in BME; active and passive sensors; sensors and transducers for different physical quantities, applied to BME. Week 7: Blood pressure and sound measurement: invasive and non-invasive blood pressure measurement principles and instrumentation; heart sounds measurement and instrumentation; catheteriazation. **Week 8: MIDTERM EXAM** Week 9: Blood flow and volume measurement: instrumentation; direct and indirect methods principles (dye injection, electromagnetic, ultrasound, thermal); plethysmography (chamber plethysmography, photo plethysmography, electric impedance). Week 10: Measurement of the respiratory dynamics: modelling of the respiratory system; principles of measurement and instrumentation for gas flow rate, lung volume, respiratory plethysmography, respiratory mechanics; measurement of gas concentration. Week 11: Clinical laboratory instrumentation: introduction; spectrophotometry; chromatography; haematology; electrophoresis. Week 12: Clinical laboratory instrumentation: chemical biosensors; electrochemical sensors; blood glucose sensors; ion-sensitive FETs; immunology sensitive FETs. Week 13: Devices for therapy and rehabilitation: devices for therapeutic stimulation (electrical, ultrasound, optical, laser etc.). Week 14: Devices for therapy and rehabilitation: implantable therapeutic devices (pacemakers, cardioverters/defibrillators, cohlear, deep brain stimulation, pain etc.); orthosis and prothesis. Week 15: Principles of medical devices and system safety and regulation Instrumentation: physiological effects of electricity; macro- and micro shock hazards; electrical safety principles and standards; safe equipment design. **Week 16: FINAL EXAM**
Teaching Methods Description	● Interactive lectures and communications with students ● Tutorials

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	0 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	30 %
	Presentation	0 %	Final Exam	40 %

	Total	**100 %**
Learning Outcomes	The students will be able to: 1. Identify and measure medical signals. 2. Record, display and analyze different types of biomedical signals. 3. Describe the principle of operation and applications of basic medical instruments and systems. 4. Describe and explain the origin of biopotentials. 5. Describe different amplifier designs and explain associated processing of the signal. 6. Describe and design the device-to-PC interface design. 7. Describe and explain principles of basic biomedical and biosensors. 8. Describe biopotential electrodes. 9. Design amplifiers of biological signals. 10. Describe and explain principles and instrumentation for measurement of blood pressure, sound, blood flow, blood volume and respiratory system. 11. Describe and explain principles and instrumentation in clinical laboratory instrumentation including chemical biosensors. 12. Describe and explain principles and instrumentation of therapeutic and prosthetic devices including implantable devices. 13. Understand basic principles of medical devices and system safety and regulation, search national and/or international rules for medical devices and apply them in the case studies.	
Prerequisite Courses	None	
Language of Instruction	English	
Mandatory Literature	Raden, J. F. (2010). *Handbook of Modern Sensors, Physics, Designs and Applications*. New York, NY, USA: Springer-Verlag	
Recommended Literature	Enderle, J. & Bronzino, J. (2011). *Introduction to Biomedical Engineering*, 3rd ed. Burlington, MA, USA: Elsevier Academic Press Webster, J. G. & Eren, H. (2014). *Measurement, Instrumentation, and Sensors Handbook, 2nd ed.* Boca Raton, FL, USA: CRC Press	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	20	20
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	1	20	20
Seminar / Presentation	1	30	30
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 528	**Course Name:** Medical Imaging and Image Processing		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week**: 3+0		**Total Hours:** 45+0

<table>
<tr><td>Course Description</td><td colspan="4">This course is introducing Master students to biomedical imaging techniques, such as ultrasound, X-ray, CT, MRI, PET, SPECT, and others. The background of each medical imaging system is covered along with handling techniques, image generation and image processing and storage.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">• To introduce students to the different techniques used for the acquisition, processing and storage of medical images for the purpose of diagnostic and treatment of patients.
• To provide knowledge about different medical imaging modalities such as radiographic imaging, nuclear medicine, magnetic resonance and ultrasound.
• To bring students to understanding of the operation of the instrumentation utilized in various imaging modalities.</td></tr>
<tr><td>Course Content</td><td colspan="4">Week 1: Introduction to medical imaging: medical imaging objectives; common medical imaging systems (X-ray, CT or CAT, PET, SPECT, ultrasound, MRI)
Week 2: Medical imaging system (MIS), Image communication and archiving (PACS, DICOM etc)
Week 3: Image quality: contrast; modulation, modulation transfer function; resolution; noise; signal to noise ratio (SNR); non-random effect, artefacts; distortion; accuracy.
Week 4: Electromagnetic spectrum: X-radiography; computed tomography; nuclear imaging (SPECT, PET).
Week 5: Introduction to radiography: ionization; forms of ionizing radiation; nature and properties; attenuation of electromagnetic radiation; radiation dosimetry.
Week 6: Projection radiography: instrumentation (X-ray tubes, filtration and restriction; X-ray image intensifier); noise; scattering.
Week 7: Recap
Week 8: MIDTERM EXAM
Week 9: Computed tomography: instrumentation; image formation; Radon transform; image reconstruction from projections (back projection; filtered back projection; algebraic reconstruction techniques); image quality.
Week 10: Nuclear medicine: instrumentation (collimators, scintillation crystal, photomultiplier tubes, image capture); image formation; image quality; planar scintigraphy; single photon emission computed tomography (SPECT); positron emission tomography (PET)
Week 11: Physics of ultrasound: wave equation; wave propagation; Doppler effect; beam pattern formation and focusing.
Week 12: Ultrasound imaging system: ultrasound instrumentation (transducer, probes); ultrasound imaging modes; steering and focusing; three-dimensional ultrasound imaging.
Week 13: Physics of magnetic resonance imaging (MRI): nuclear magnetism; spin; Larmor frequency; RF excitations; resonance condition; free precession and relaxation.
Week 14: Magnetic resonance imaging system: instrumentation (main magnet, gradient system, RF system); image reconstruction; image quality.
Week 15: Recap
Week 16: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">● Interactive lectures and communications with students ● Tutorials</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>0 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>30 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">The students will be able to:
1. Identify, manipulate and process medical images.
2. Visualize and analyze different types of medical imaging signals.
3. Describe the principle of operation and applications of medical imaging systems, including the image communication an archiving standard.
4. Describe key modalities in radiographic imaging, including generation and detection of ionizing radiation and its effects on human body.
5. Describe the principle of projection radiography systems, including X-ray and fluoroscopy systems.</td></tr>
</table>

	6. Explain the concept of image reconstruction in medical imaging, including Computed Tomography (CT) products. 7. Describe the principles of radioisotope imaging, including planar scintigraphy, Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET). 8. Describe the principle of nuclear magnetic resonance. 9. Explain the contrast mechanism in magnetic resonance images and select pulse parameters to maximize contrast between tissue types. 10. Explain what ultrasound is and how ultrasound image is formed. 11. Explain the choice of a specific medical imaging system based on medical application (advantages and disadvantages of a specific imaging modality with respect to the others).
Prerequisite Courses	None
Language of Instruction	English
Mandatory Literature	1. Handbook of Medical Imaging: Processing and Analysis Management (Biomedical Engineering), Isaac Bankman (Editor)
Recommended Literature	1. Medical Image Processing: Techniques and Applications, Geoff Dougherty, Springer Science & Business Media 2. Taking Image Processing to the Next Level, Ralph Schaetzing 3. Applied Medical Image Processing: A Basic Course, Wolfgang Werner Birkfellner

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	20	20
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	1	20	20
Seminar / Presentation	1	30	30
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 529	**Course Name:** Biomaterials and Artificial Organs		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week**: 3+0		**Total Hours:** 45+0

<table>
<tr><td>Course Description</td><td colspan="4">This Master level course is designed to introduce students to biomaterials and other general materials that can be used in bioengineering. Along with the general introduction to bone and muscle tissues that are manipulated through bioengineering approach, the students are given an overview of metals, ceramics, polymers and elastomers and composites. Each class of biomaterial is discussed in depth, along with its practical usage in tissue implantation and tissue engineering.</td></tr>
<tr><td>Course Objectives</td><td colspan="4">● To introduce students to the concepts underlying the mechanical and biological properties of synthetic and natural biomaterials.
● To introduce the basics of tissue implantation and tissue engineering.</td></tr>
<tr><td>Course Content</td><td colspan="4">Week 1: Ideal materials - Linear elastic solid and linear viscous fluid, effect of load and deformation.
Week 2: Meaning and definition of stress and strain. Mechanical properties of elastic material, Modulus and Compliance, anisotropy.
Week 3: Non-elastic behaviour-failure, plasticity and viscoelasticity.
Week 4: Structure and mechanical properties of general classes of materials-metals, ceramics, polymers and elastomers, composites, body tissues.
Week 5: Examples of biomaterial use, joint replacement, soft tissue replacement, artificial organs.
Week 6: Metallic implant materials - Stainless steel, cobalt-chrome, titanium and alloys. Structure and mechanical properties. Fabrication-casting, forging, machining.
Week 7: Ceramics - Aluminum and Zirconium based, glass ceramics and bio-glasses, natural ceramics, hydroxyapetite. Structure and mechanical properties, fabrication.
Week 8: MIDTERM EXAM
Week 9: Polymers, addition and condensation. General structure and mechanical properties, glassy and elastomeric polymers. Polymeric implant materials examples, Poly-amides, -ethanes, -acrylates, -urethanes, hydrogels, fluorocarbons, dialyser membranes. Fabrication of devices.
Week 10: Composites, fibres and matrix materials. Relation between structure and mechanical properties.
Week 11: Overview of mechanical properties of bone and soft tissue. Case study - total hip replacement, metal/ceramic, polyethylene, bone cement. Outcome of implantation.
Week 12: Interaction of biomaterials and the body. Stability, adsorption, corrosion: electrochemistry, Pourbaix diagram. Resorbable biomaterials.
Week 13: Biocompatibility, meaning; cell and tissue culture methods - cytotoxicity, biofunctionality, animal tests.
Week 14: Haemocompatibility, example of dialyser membranes. Blood vessel damage, tissue damage; clotting, complement and white cell activation.
Week 15: Concepts of cell and tissue engineering. Role of biomaterials.
Week 16: FINAL EXAM</td></tr>
<tr><td>Teaching Methods Description</td><td colspan="4">● Interactive lectures and communications with students ● Tutorials</td></tr>
<tr><td rowspan="7">Assessment Methods Description (%)</td><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>0 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>30 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">The students will be able to:
1. Explain the concepts of stress and strain, and the parameters used to characterize the physical properties of materials.
2. Describe the composition, structure and mechanical properties of the main classes of biomaterials: metals, ceramics, polymers, composites and the body tissues; explain and give an example of how composition, structure and treatment modify the mechanical properties.
3. Explain how to determine the mechanical properties of materials experimentally; interpret the results of tests and data sheets.
4. Describe the interactions of materials and the body tissues - stability, corrosion, bio- and hemo-compatibility; explain how these interactions are assessed and influenced by material choice and modification.</td></tr>
</table>

	5. Describe and the developments of biomaterials for cell and tissue engineering; give an example of tissue engineering technique. 6. Describe and give an example of how biomaterials are used to fabricate devices for clinical use.
Prerequisite Courses	None
Language of Instruction	English
Mandatory Literature	Temenoff, J. S. & Mikos, A. G. (2009). *Biomaterials: The Intersection of Biology and Materials. International Edition.* New York City, NY, USA: Pearson
Recommended Literature	Park J. & Bronzino J. (2002). *Biomaterials: Principles and Applications, 1st ed*. Boca Raton, FL, USA: CRC Press

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	20	20
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	1	20	20
Seminar / Presentation	1	30	30
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 530	**Course Name:** Anatomy, Physiology, Cell Biology with Histology		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0

<table>
<tr><td>Course Description</td><td>The course offers an overview of the functioning systems of the human body. The physiology of cells as well as the muscular, nervous, circulatory, respiratory, endocrine, digestive, and urogenital systems is explored. Emphasis is placed on the integration of the individual function of different cells and organ systems into a functional whole, the feedback mechanisms that account for necessary balances, and the consequences of disease. Examples of engineering approaches used to monitor physiological processes and correct physiological deficiencies are included.</td></tr>
<tr><td>Course Objectives</td><td>The cognitive, affective and behavioral objectives of this course are following:
Introduction to metabolic pathways commonly used by cells and explaining how enzymes function in those pathways.
Explaining how neurons communicate with each other and with other cells, such as muscles and glands.
Providing basic concepts of blood and how it circulates in the body.
Describing how the body defends itself against foreign invaders.
Teaching the respiratory system function including breathing and gas exchange in the lungs and body tissues.
Explaining how the digestive system mechanically and chemically breaks food down for absorption.
Giving an overview of urine formation and its hormonal control.
Explaining the difference between reproductive processes that occur in males and those that occur in females.</td></tr>
<tr><td>Course Content
(weekly plan)</td><td>Introduction to the course
Introduction to cell biology
Introduction to tissues
Cartilage and Bones
Muscles
Central and Perifery Nerve system
Immune System and Blood
: MID-TERM EXAM WEEK
Lymphoid system, Skin
0: Digestive System
1: Glands associated with the digestive system and Respiratory System
2: Skin and Urinary System
3: Endocrine system
4: Male and female reproductive systems
5: Sensory organs

Week 16: FINAL EXAM WEEK</td></tr>
<tr><td>Teaching Methods Description</td><td>Interactive lectures and communication with students
Discussions and group work</td></tr>
<tr><td>Assessment Methods Description (%)</td><td><table>
<tr><td>Quiz</td><td>0 %</td><td>Lab/Practical Exam</td><td>0 %</td></tr>
<tr><td>Homework</td><td>0 %</td><td>Term Paper</td><td>0 %</td></tr>
<tr><td>Project</td><td>0 %</td><td>Attendance</td><td>0 %</td></tr>
<tr><td>Midterm Exam</td><td>30 %</td><td>Class Deliverables</td><td>30 %</td></tr>
<tr><td>Presentation</td><td>0 %</td><td>Final Exam</td><td>40 %</td></tr>
<tr><td>Total</td><td colspan="3">100 %</td></tr>
</table></td></tr>
<tr><td>Learning Outcomes</td><td>On successful completion of this course, students should be able to:
Recall the basics of physiology of different organ systems
Identify the structure and function of various systems
Interpret and criticize the concept of experimental animals
Design and set up animal experiments in a bioethical manner</td></tr>
<tr><td>Prerequisite Course(s)
(if any)</td><td>None</td></tr>
</table>

Language of Instruction	English
Mandatory Literature	Junqueira, L. C., & Carneiro, J. (2005). *Basic histology text and atlas, 11th ed*. London, UK: McGraw Hill. Stanfield, C. (2010). *Principles of Human Physiology, 4th ed*. New York City, NY, USA: Pearson
Recommended Literature	Fox, S. I. (2008). *Human physiology, 10th ed.* New York City, NY, USA: McGraw Hill

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	20	20
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	1	20	20
Seminar / Presentation	1	30	30
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: GBE 537	**Course Name:** Scientific Research Methods in Biomedical Engineering		
Level: Master	**Year:** I	**Semester:** I, II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is introducing the nature of research in natural sciences, most prominently in biomedical engineering. All phases of designing and performing the research, converting obtained data into meaningful results, and result presentation through scientific articles are covered during the course. Student will learn how to identify problems to study, develop hypotheses and research questions, specify independent and dependent variables, check for the validity and reliability of studies and design research projects. You will be exposed to the broad range of designs used in communication research from laboratory and field experiments, surveys, content analysis, focus groups and in-depth interviewing. At the end of semester, students are supposed to analyze original scientific articles and case studies in order to understand the difference. Active student participation and preparation of high quality presentations are of the highest importance.		
Course Objectives	The course aims to provide in-depth knowledge of research design and methodology. The cognitive, affective and behavioral objectives of this course are following: ● Teaching research methodology concepts in the field of biomedical engineering theoretically and practically. ● Enabling graduates to report a research study and thesis proposal in their areas of interest during the semester. ● Encouraging graduates to deliver effective presentations of their research.		
Course Content (weekly plan)	Week 1: The nature of research in medical and biological engineering Week 2: Formulating and clarifying research topic, objectives, and goals Week 3: Making differences between case study, review, and original scientific paper Week 4: Critically reviewing scientific literature Week 5: Understanding research materials and methods, philosophies, and approaches Week 6: Formulating experimental research design Week 7: Negotiating access and research ethics **Week 8: MID-TERM EXAM** Week 9: Introduction in scientific writing and research Week 10: Data types and data collection techniques Week 11: Quantitative and qualitative methods and data analyses Week 12: Ethical issues Week 13: Analyzing original scientific articles Week 14: Developing research proposal Week 15: Presentations of student project results **Week 16: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions and group works ● Presentations		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	30 %	Final Exam	30 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Understand different scientific research designs and methods 2. Learn how to set up a research study 3. Begin to work effectively as part of a team 4. Develop interpersonal, organizational and problem-solving skills within a managed environment 5. Exercise some personal responsibility 6. Present gained results 7. Interpret scientific data

	8. Perform literature reviews and reference relevant scientific literature 9. Understand correct ways to refer to and cite from scientific literature
Prerequisite Course(s) (if any)	None
Language of Instruction	English
Mandatory Literature	Various scientific papers in the field of BME
Recommended Literature	None

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)			
Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Pre-Studying for the lectures	0	0	0
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	20	20
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	1	20	20
Seminar / Presentation	1	30	30
Total Workload			149
ECTS Credit (Total Workload / 25)			6