INTERNATIONAL BURCH UNIVERSITY

FACULTY OF ENGINEERING AND NATURAL SCIENCES

DEPARTMENT OF GENETICS AND BIOENGINEERING

THIRD CYCLE STUDY PROGRAM SPECIFICATION

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1. PROGRAM DESCRIPTION

1.1. Introduction

Recent advances in the fields of genetics and bioengineering have triggered a waste number of scientific discoveries and inventions in different subfields. This puts the disciplines at the forefront of engineering, and the prime goal of our studies is to translate our understanding of the fundamental concepts into useful and highly applied processes, methods, devices, therapies, and diagnostics tools that will benefit society and advance human health.

1.2. Vision

Our vision is to create an environment that is dynamic, interdisciplinary, ethical, enterprising, engrossing, and modern. Such an environment is also open to originality, active in social matters, mindful of human dignity, and is producing high quality applied science.

1.3. Mission

The mission of the Department of Genetics and Bioengineering is to educate its scholars about the principles of life sciences, molecular genetics, genetics and bioengineering in order to make them capable of developing solutions to the problems within their chosen fields. Furthermore, the aim is to enhance scientific skills of our graduates, while emphasizing teamwork, leadership, and independent and innovative mindsets.

1.4. Program

Doctorate study at the Department of Genetics and Bioengineering is a three-year program that comprises a mandatory total of 180 ECTS credits of formal coursework and dissertation. Students learn about advanced concepts in applied genetics and bioengineering in their first year of studies and have an opportunity to improve their professional skills within the areas of their interests through a number of elective courses. The PhD is a competitive program designed to provide graduates with experiences and training beyond the research lab, in an effort to better prepare them for the wealth of opportunities available to them, including careers in academia, business, and industry. 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.
- Application of latest scientific achievements from the field of genetics and bioengineering.
- Fundamentals of genetics, bioengineering, and data analysis.
- Bioinformatics concepts, applications, and design.

1.5. Objectives and Outcomes

The objectives of PhD program are as follows:

- To produce graduates skilled in the fundamental concepts of genetics and bioengineering necessary for success in various engineering fields or postdoctoral studies.
- To prepare graduates to pursue career choices in genetics and bioengineering, forensics, bioinformatics, biomedical fields, microbiology, or related interdisciplinary fields that benefit from a strong background in applied sciences or engineering.
- To equip graduates with problem solving skills, laboratory skills, and design skills for technical careers.

- To develop graduates abilities to communicate and demonstrate teamwork skills as well as an appreciation for ethical behavior necessary to thrive in their careers.
- To prepare graduates to be 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 this PhD Genetics and Bioengineering program, students should be able to:

- Show an advanced level of knowledge in the field of genetics and bioengineering.
- Relate to various fields of basic sciences and electives necessary for the bioengineering profession.
- Interpret and discuss current topics in the field.
- Apply computer programs and program languages necessary to adequately perform tasks in the bioengineering field in a scientific manner through the development of computer literacy.
- Develop laboratory skills and practice safe laboratory work
- Apply laboratory and technical skills in experiments and projects preparations.
- Operate various instruments and bioengineering laboratory machines.
- Perform clinical analysis.
- Prepare scientific papers and projects.
- Develop skills and abilities to thrive in a team as well as a multidisciplinary environment.
- Improve and enhance old and develop new protocols in the laboratory.
- Critically analyze scientific work and identify possibilities for their improvement.
- Compare different methodologies in order to improve and enhance them.
- Integrate various approaches and designs in order to design optimal experiments.
- Propose solutions to current problems in the field of genetics and bioengineering
- Criticize and validate current scientific paradigms.

1.6. Learning and Teaching

Our learning and teaching methods provide high quality learning opportunities, so that candidates can effectively demonstrate achievements in the courses and modules in their route of study.
We aim to foster the development of independent study skills, intellectual autonomy, and sense of curiosity, while encouraging commitment to lifelong learning and continuous professional development. Furthermore, graduates 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 allows graduates to take on greater self-direction. Group and team work are of particular focus during the scholars' course of study as they provide enriching interactions that shape them both socially and intellectually.

Our courses are usually composed of lectures, seminars, tutorials, and practical laboratory sessions. The use of simulations, case studies, projects, practical work, 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.

1.6.1. 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 set-ups.

Practical sessions: During undergraduate studies, practical sessions are organized as a series of biochemistry, molecular biology, genetics, and bioinformatics practices with short introductory lectures on theory. However, practical work during the third study cycle mainly revolves around the chosen topic of doctoral dissertation. Graduates are given freedom to design their research and conduct it in agreement with their mentors. In that way, they are learning how to conduct independent work and how to analyze and present the results of their studies, but are also given a change to expand both theoretical and experimental knowledge in their areas of interest.

Group projects: The group project provides an opportunity for graduates to solve real genetics, 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, and meaningful collaborations, that enables our graduates to reach their full intellectual and academic potential.

Individual projects: Individual projects involve literature reviews, problem specification, and discussion of the obtained results. This enables a graduate to utilize covered theoretical techniques by applying them in library settings.

Expert (guest) lectures and seminars: Guest lectures and seminars provide graduates with opportunities to hear internal and external visiting speakers. Through this immersion in real-world science, graduate 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 outcomes-based learning assessment is to improve the quality of learning and teaching at the Department of Genetics and Bioengineering. The fundamental principles are:

- Student's 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.
- Student has to do their PhD thesis independently and write and publish papers in international refereed journals.
- Student has to present their scientific achievements within international scientific conferences, symposiums, seminars, workshops, etc.
- Student is expected to write PhD thesis in the partial fulfillment of the requirements for the degree of doctor of philosophy in genetics and bioengineering.

Assessment of the GBE learning outcomes (GBELOs) begins with the normal assessment process in the major courses that are taken by 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 done via:

- Written examinations
- Written essay assignments
- Evaluation of practical work
- Group project report and team presentation
- Individual project report and short presentation.
- Scientific publications

1.8. Skills and Other Attributes

Upon successful completion of the PhD level, graduates should be able to demonstrate that they:

- Have 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 for the discipline).
- Can communicate information, ideas, problems, and solutions to both specialist and non-specialist audiences.
- Have the qualities and transferable skills requiring the exercise of initiative and personal responsibility, decision-making in complex and unpredictable contexts, and learning ability needed to undertake appropriate further training of a professional or equivalent nature.

1.8.1. Intellectual Skills

By the end of the study, a graduate will have developed skills in:

- Synthesis: integrate theory and practice and devise appropriate theoretical models of genetics 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.

1.8.2. Discipline-specific Practical Skills

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

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

1.8.3. Transferable Skills

By the end of their doctoral studies, graduates will have a range of transferable skills including those in:

- Managing self-learning and conducting independent thinking and study.
- Problem specification and modeling.
- Applying mathematical and computational methods to solve (bioengineering) problems.
- Use of general information technology.
- Managing a research project, including planning and time management.
- Conducting an engineering-based research-based work, from hypothesis to report writing.
- Working in a multi-disciplinary team.
- Critical analysis.
- Scientific publication skills

1.9. 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
- External examiners reports
- Accreditation visits
- Curriculum area review
- Course committees
- Annual and periodic review.

Mechanisms for gaining student feedback on teaching quality and their learning experience:

- Questionnaires collected for each component of the course and considered by the course director/tutors in a Department meeting and acted on as appropriate.
- Term individual meetings between students and the course director.
- Self-assessment progress reports completed by students at the end of each term.

Mechanisms for the review and evaluation of teaching, learning, assessment, 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. This meeting is also used to help spreading the best practice for teaching and learning techniques.
- Examiners reports (both internal and external) on the examinations in a particular year, commenting on passing rates, standards of learning, and examination performance.
- Analyzing evaluation questionnaires.
- Annual Course Director Report to the Department Academic Committee with details on admissions, staffing, course changes and feedback, student performance, destination of graduated PhD students, and any difficulties encountered while teaching 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.

Indicators of quality and standards:

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

1.10. Criteria for Admission

The Department of Genetics and Bioengineering at IBU invites applications from candidates whose width of knowledge and curiosity suggests 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, work experience, and community involvement.

1.10.1. Academic Ability

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

1.10.2. English Language Requirement

Students whose first language is not English are also urged to apply. However, mastery of the English language is tested via standardized means, such as IELTS and TOEFL. For IELTS, an overall score of 5 is considered minimum, while for TOEFL, the required overall score is 180 for the computer-based and 64 for the internet-based test.

1.10.3. Suitability

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

2. CURRICULUM OF DEPARTMENT OF GENETICS AND BIOENGINEERING

1. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE xxx	Elective I	3	0	6
GBE xxx	Elective II	3	0	6
GBE xxx	Elective III	3	0	6
GBE xxx	Elective IV	3	0	6
GBE 693	Seminar I	0	3	6
	Total	**12**	**3**	**30**

2. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE xxx	Elective V	3	0	6
GBE xxx	Elective VI	3	0	6
GBE xxx	Elective VII	3	0	6
GBE xxx	Elective VIII	3	0	6
GBE 694	Seminar II	0	3	6
	Total	**12**	**3**	**30**

3. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 695	PhD Dissertation I	0	0	30
	Total	**0**	**0**	**30**

4. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 696	PhD Dissertation II	0	0	30
	Total	**0**	**0**	**30**

5. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 697	PhD Dissertation III	0	0	30
	Total	**0**	**0**	**30**

6. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 698	PhD Dissertation IV	0	0	30
	Total	**0**	**0**	**30**

COURSES				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
GBE 600	Molecular Biomedicine	3	0	6
GBE 601	Genome Organization	3	0	6
GBE 602	Functional Genomics and Genome Analysis	3	0	6
GBE 603	Phylogenetics	3	0	6
GBE 604	Human, Animal, and Plant Genetics in Forensic Science	3	0	6
GBE 605	Glycobiology	3	0	6
GBE 606	RNAi Technology in Eukaryotes	3	0	6
GBE 607	Advanced Topics in Genome Sequencing and Metagenomics	3	0	6
GBE 608	Medical Genetics	3	0	6
GBE 609	Biological Signal Transduction	3	0	6
GBE 610	Computational Modeling of Biomolecules	3	0	6
GBE 611	Emerging and Reemerging Pathogens	3	0	6
GBE 612	Molecular Diagnostics in Microbiology	3	0	6
GBE 613	Antimicrobial Resistance	3	0	6
GBE 614	Advanced Neuroengineering	3	0	6
GBE 615	Experimental Techniques in Molecular Biology	3	0	6
GBE 616	Advanced Biochemistry	3	0	6
GBE 617	Environmental Microbiology	3	0	6
GBE 618	Biomedical Imaging	3	0	6
GBE 619	Advanced Topics in Neurogenetics	3	0	6
GBE 620	Advanced Topics in Molecular Forensic Genetics and Anthropology	3	0	6
GBE 621	Exploring Popular Misconceptions of Modern Biotechnology	3	0	6
GBE 693	Seminar I	0	3	6
GBE 694	Seminar II	0	3	6
GBE 695	PhD Dissertation I	0	0	30
GBE 696	PhD Dissertation II	0	0	30
GBE 697	PhD Dissertation III	0	0	30
GBE 698	PhD Dissertation IV	0	0	30

Course Code: GBE 600	**Course Name:** MOLECULAR BIOMEDICINE		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	The field of molecular biomedicine is a novel interdisciplinary application of biological sciences that mainly uses molecular-biological and cell-biological methods to discover how cells exchange information, which molecules control their behavior, and what faults in the dialogue between cells cause diseases to develop. Among the others, molecular biomedicine covers the areas of cell cycle and cellular signaling pathways, investigation of mutations in hereditary material that are responsible for the disease development, use of stem cells in treating diseases, and the study of inflammation processes. Additionally, novel techniques in genomics, proteomics, and computer science are used as helpful tool in setting the diagnosis and disease treatment.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to the field of biomedicine. ● Providing an outline of basic anatomic concepts and structures. ● Explaining the basic biochemical and cell biology-related concepts. ● Giving an overview of the principles of the information flow in the cell.		
Course Content	Week 1: Introduction to molecular biomedicine Week 2: Basic organization of a human cell Week 3: Cell cycle: Cell division, interphase, and apoptosis Week 4: Cellular signaling pathways Week 5: The role of mutations and chromosomal translocations in the regulation of cell cycle Week 6: Research in molecular biomedicine: Karyotype and karyogram and in situ hybridization techniques Week 7: Research in molecular biomedicine: Clinical immunology and clinical chemistry Week 8: MID-TERM EXAM Week 9: Research in molecular biomedicine: Stem cells Week 10: Genomics technologies in molecular biomedicine Week 11: Proteomics technologies in molecular biomedicine Week 12: Software tools in molecular biomedicine Week 13: Molecular biomedicine in cerebrovascular diseases Week 14: Molecular biomedicine in diseases of gastrointestinal system and lungs Week 15: Molecular biomedicine in diseases related to metabolism Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Manage an integrated approach to the study of various topics 2. Clarify fundamental aspects of cell biology, biochemistry, signal transduction and systems physiology 3. Employ new and advanced computer software tools in research 4. Explain the basic principles of structural and functional concepts of biological macromolecules 5. Show an ethical and safety attitude to biomedical work
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Trent, R.J. (2005). *Molecular medicine, 3rd ed.* Waltham, MA, USA: Academic Press.
Recommended Literature	Weinberg, R.A. (2013). *The biology of cancer, 2nd ed.* New York City, NY, USA: Garland Science. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P. (2007). *Molecular biology of the cell, 5th ed.* New York City, NY, USA: 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 credits (total workload / 25)			6

Course Code: GBE 601	**Course Name:** GENOME ORGANIZATION		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	The hereditary material of all living organisms is composed of an array of four nucleotides arranged in a specific pattern. Such an arrangement of nucleotides represents unapparent information that is hard to understand when not deeply analyzed. Genomic organization of an organism offers a number of useful information about that organism. In the first part of this course, PhD students will go through the advanced applied concepts of molecular biology, with an emphasis on gene and genome organization within different evolutionary levels. The second part covers comparative analysis of functional and structural genome organization within different classes of living organisms: bacteria, viruses, plants, animals, and humans.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Learning the details of gene structure and function (promoter, terminator, ORF). ● Developing an understanding of different aspects of genome organization. ● Learning about functional and structural genome function. ● Understanding evolutionary processes within human, animal, plant, and bacterial genome development. ● Developing a deep understanding of genome differences between different classes of living organisms: bacteria, viruses, plants, animals, and humans.		
Course Content	Week 1: Introduction to the course Week 2: The basic concepts in molecular biology and genome research Week 3: Genome: Definition, structure, and organization Week 4: Genome: Coding and non-coding regions Week 5: Transcription and translation; RNA- and protein-coding genes Week 6: Gene cloning: Restriction endonucleases and vectors Week 7: Gene evolution Week 8: MID-TERM EXAM Week 9: Analysis of genetic variants Week 10: Products of native and manipulated cloned genes Week 11: Organization of a viral genome Week 12: Organization of a bacterial genome Week 13: Organization of a plant genome Week 14: Organization of an animal genome Week 15: Organization of a human genome Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 about the gene structure: promoter, terminator, ORF, etc. 2. Categorize different aspects of gene cloning 3. Prepare a cDNA library 4. Develop a deep comprehension of genome analysis 5. Integrate the knowledge of PCR and sequencing in research
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Hartwell, L., Hood, L., Goldberg, M., Reynolds, A.E. & Silver, L. (2010). *Genetics: From genes to genomes, 4th ed*. New York City, NY, USA: McGraw-Hill Education.
Recommended Literature	Brown, T.A. (2006). *Genomes 3, 3rd ed.*New York City, NY, USA: 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 credits (total workload / 25)			6

Course Code: GBE 602	**Course Name:** FUNCTIONAL GENOMICS AND GENOME ANALYSIS		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Functional genomics and genome analysis are two closely related disciplines and are, thus, organized as a single course within doctoral studies for those graduates who are willing to take advantage of computational analyses in genetics and bioengineering. During the course, graduates are expected to learn how to use the wealth of data produced by genomics, transcriptomics, and proteomics projects to describe gene/protein functions and interactions and to focus on dynamic aspects such as gene transcription, translation, and protein–protein interactions, as opposed to the static aspects of the genomic information such as DNA sequence or structures thought in classical genomics courses. The course also covers the application of computer technology to the management of biological information. An example of successful synthesis of computer tools and genetics is the Human Genome Project which is mentioned on a few occasions during the course as an ultimate example of importance of modern technologies in genetics.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Explaining DNA, RNA and protein sequence analysis. ● Teaching advanced database searching. ● Explaining nuclear and organelle genome analysis.		
Course Content	Week 1: Introduction to the course Week 2: Basics of *in silico* genomics research (sequence information, genome browsers and biomedical literature) Week 3: Pairwise sequence alignment Week 4: Alignment of distantly related sequences using PSSMs and hidden Markov model Week 5: Multiple sequence alignment Week 6: Molecular evolution and phylogenetic reconstruction Week 7: Organization of eukaryotic chromosomes: ENCODE project **WEEK 8: MID-TERM EXAM** Week 9: Student presentations Week 10: NGS platforms and analysis of NGS data Week 11: Analysis of RNA data: small RNAs, ESTs and transcriptomics studies Week 12: Gene expression analysis (microarrays and RNA-seq data) Week 13: Proteomics studies (protein sequence and structure analysis, protein-protein interaction networks) Week 14: Functional genomics Week 15: Guest lecture **WEEK 16: FINAL EXAM**		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student presentations ● Guest lectures		

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

Learning Outcomes	After completion of this course, students should be able to: 1. Compare DNA, RNA and protein sequence analysis 2. Use current bioinformatics tools in genomic research 3. Propose genome analysis and molecular phylogeny 4. Complete advanced database searching 5. Recall basic concepts about functional genomics
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Pevsner, J. (2015). *Bioinformatics and Functional Genomics, 3rd ed*. Hoboken, NJ: John Wiley & Sons.
Recommended Literature	Database information Benfey, P. (2004). *Genomics*. Upper Saddle River, NJ, USA: Prentice Hall. Hunt, S.P. & Livesey, R. (2000). *Functional genomics: A practical approach (The practical approach series), 1st ed.*Oxford, UK: 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 credits (total workload / 25)			6

Course Code: GBE 603	**Course Name:** PHYLOGENETICS		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Phylogenetics is a modern-era area of science that is offered to our doctorate students as an elective course. The first goal of the course is to distinguish between basic terms: phylogenesis, phylogeny, and phylogenetics. The course is utilizing sequencing data to discover and analyze evolutionary relationships between species and populations. Furthermore, approximations of an evolutionary history of specific taxonomic groups are made according to sequence analyses. The ultimate goal of the course is to make the graduate student familiar with the theoretical and practical aspects of phylogenetic analysis.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to the basics of bioinformatics needed to study phylogenetics. ● Explaining various software used for the study of phylogenetics. ● Teaching graduates to construct phylogenetic trees.		
Course Content	● Basic concepts of molecular evolution ● Sequence databases and database searching ● Multiple sequence alignment ● Genetic distances and nucleotide substitution models ● Phylogenetic inference based on distance models ● Phylogenetic inference using maximum likelihood methods ● Bayesian phylogenetic analysis using MRBAYES ● MID-TERM EXAM ● Phylogeny inference based on parsimony and other methods using PAUP ● Phylogenetic analysis using protein sequences ● Selecting models of evolution ● Molecular clock analysis ● Testing tree topologies ● Natural selection and adaptation of molecular sequences ● Estimating selection pressures on alignment of coding sequences ● FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 the basics of sequence analysis needed for phylogenetic studies 2. Analyze phylogenetic trees 3. Create phylogenetic trees 4. Interpret phylogenetic trees 5. Apply knowledge of bioinformatics in phylogenetic research
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Lemey, P., Salemi, M. & Vandamme, A.-M. (2009). *The phylogenetic handbook: A practical approach to phylogenetic analysis and hypothesis testing, 2nd ed*. Cambridge, UK: Cambridge University Press.
Recommended Literature	Wiley, E.O. & Lieberman, B.S. (2011). *Phylogenetics: Theory and practice of phylogenetic systematics, 2nd ed*. Hoboken, NJ, USA: Wiley-Blackwell.

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 credits (total workload / 25)			6

Course Code: GBE 604	**Course Name:** HUMAN, ANIMAL, AND PLANT GENETICS IN FORENSIC SCIENCE		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Through this course, graduate student will be introduced to the theoretical and practical aspects of DNA analysis in plants, animals, and human. Techniques of DNA isolation, quantification, amplification, and sequencing are covered, as well as differences in approach depending on the starting material for DNA analysis. Since animal and plant evidence is often found at the crime scene, it is very important to be familiar with the species determination. In this course, species determination is done using molecular techniques, that is, on the basis of variations in DNA. When it comes to human identification and individualization, both historical (ABO blood system, RFLP) and modern (STR- and SNP-based) techniques are covered.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing an overview of DNA isolation methods from various materials. ● Revising DNA quantification and amplification. ● Revising DNA sequencing.		
Course Content (weekly plan)	● Introduction; Basic experimental techniques in forensic genetics ● Specificities of plant DNA isolation ● Plant DNA amplification and sequencing ● Determination of plant species using molecular techniques ● Specificities of animal DNA isolation ● Animal DNA amplification and sequencing ● Determination of animal species using molecular techniques ● MID-TERM EXAM		● Human DNA isolation using standard protocols ● Human DNA isolation using commercial kits ● Human DNA quantification and amplification ● Human DNA sequencing ● Human identification and individualization: Historical methods ● Human identification and individualization: Modern methods ● DNA profile analysis and basic statistical models ● FINAL EXAM
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Employ various protocols for DNA isolation from plant, animal and human material 2. Present species determination 3. Perform DNA quantification and amplification 4. Repeat various sequencing methods 5. Analyze and interpret DNA profiles
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Butler, J.M. (2011). *Advanced topics in forensic DNA typing: Methodology, 1st ed.* Waltham, MA, USA: Academic Press.
Recommended Literature	Miller, H., Witherow, D.S. & Carson, S. (2011). *Molecular biology techniques, 3rd ed.* Waltham, MA, USA: 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 credits (total workload / 25)			6

Course Code: GBE 605	**Course Name:** GLYCOBIOLOGY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	The primary aim of this course of the third study cycle is to provide an overview of fundamental facts, concepts, and methods in glycobiology. The topics covered within the course mainly revolve around biological roles and compartmentalization of glycans and glycan structure as a means of classification. Also, evolutionary development of different classes of glycans is covered. The course is supported by selected readings from the textbook, "Essentials of Glycobiology", and original literature. This is a course based on active participatory discussion guided by the instructor.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to the process of glycosylation. ● Demonstrating glycan structures. ● Explaining glycans and their role in physiology and disease. ● Explaining glycans in biotechnology.		
Course Content	● Historical background and overview of glycan diversity ● Structural basis of glycan diversity ● Cellular organization of glycosylation ● Biological roles of glycans ● A genomic view on glycobiology ● Structure and biosynthesis of glycans ● N-glycans ● MID-TERM EXAM ● O-GalNAc glycans and glycosphingolipids ● Glycosylphosphatidylinositol anchors and other classes of ER/Golgi-derived glycans ● Structures common to different glycans and evolution of glycan diversity ● lycan-binding proteins ● Glycans in physiology and disease ● Methods, applications, and chemical tools for inhibiting glycosylation ● Glycans in biotechnology and pharmaceutical industry ● FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 of glycans structure and function 2. Clarify glycans in the context of biodiversity 3. Describe glycans and their role in physiology 4. Discuss glycans and health issues 5. Explain glycans in biotechnology and pharmaceutical industry
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Varki, A. (2008). *Essentials of Glycobiology, 2nd ed.* Cold Spring Harbor, NY, USA: Cold Spring Harbor Laboratory Press.
Recommended Literature	Fukuda, M. & Hindsgaul, O. (2000). *Molecular and Cellular Glycobiology, 2nd ed.* Oxford, UK: Oxford University Press. Relevant scientific articles

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 credits (total workload / 25)			6

Course Code: GBE 606	**Course Name:** RNAi TECHNOLOGY IN EUKARYOTES		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	RNA interference (RNAi) is a process characteristic for eukaryotes. It can be defined as a biological process in which RNA molecules inhibit gene expression, either by destructing mRNA molecules or by gene silencing. During the course, graduates will get familiar with the components of RNAi machinery, including miRNA, siRNA, Dicer, RISC complex, and shRNA, as well as with methods of siRNA design and synthesis. Also, practical applications of RNAi in different species and in pharmaceutical industry are presented.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Giving an outline of the fundaments of RNAi. ● Demonstrating genes required for RNAi. ● Revising gene silencing. ● Explaining the application of RNAi in drug development		
Course Content (weekly plan)	● Introduction to RNAi ● microRNA (miRNA) and small interfering RNA (siRNA) ● Dicer in RNAi ● Genes required for RNAi; RISC complex ● Gene silencing ● Chemical synthesis of siRNA; enzymatic production of small interfering RNAs ● Rational design of siRNAs with various software ● MID-TERM EXAM ● Viral delivery of shRNAs ● Practical application of RNAi in C. elegans ● Inducible RNAi as a forward genetic tool in T. brucei ● Application of RNAi in neurons ● RNA-mediated gene silencing in fission yeast ● Drug-targeted validation; therapeutic and drug development ● High throughput genome-wide RNAi analysis ● FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Review gene silencing methods 2. Recognize genes required for RNAi 3. Illustrate the process of RNAi 4. Indicate the practical approach to RNAi 5. Interpret the use of RNAi in various fields
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Appasani, K., Fire, A. & Nirenberg, M. (2005). *RNA interference technology: From basic science to drug development*. Cambridge, UK: Cambridge University Press.
Recommended Literature	Schepers, U. (2004). *RNA interference in practice: Principles, basics, and methods for gene silencing in C. elegans, Drosophila, and mammals, 1st ed*. Weinheim, Germany: Wiley-VCH.

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 credits (total workload / 25)			6

Course Code: GBE 607	**Course Name:** ADVANCED TOPICS IN GENOME SEQUENCING AND METAGENOMICS		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Next-generation DNA sequencing (NGS) technology has revolutionized research in genetics, making complete genome sequencing an affordable and frequently used tool for a wide variety of research applications. Bioinformatics methods to support DNA sequencing have become a critical bottleneck for many researchers and organizations wishing to make use of NGS technology. This course provides a thorough theoretical introduction to the topic, as well as necessary informatics methods and tools for operating NGS instruments. Importance and application of NGS technologies are explained in great detail. Additionally, introduction to metagenomics, the branch of science that is analyzing genetic material from the environmental samples, is given at the end of the course. In that part, metagenomics is explained through its application in bacteriology.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to the basics of DNA sequencing. ● Explaining next generation sequencing. ● Teaching basic informatics needed for NGS instruments.		
Course Content	● A brief history of the discovery of DNA structure and function ● Introduction to DNA sequencing ● History of sequencing informatics ● Visualization of next-generation sequencing data ● DNA sequence alignment ● Genome assembly using generalized de Bruijndi graphs ● De novo assembly of bacterial genomes from short sequence reads ● MID-TERM EXAM ● Genome annotation ● Using NGS to detect sequence variants ● ChIP-sequencing ● RNA sequencing with NGS ● Metagenomics ● Metagenomics in bacteriology ● High performance computing in DNA sequencing informatics ● FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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: 3. Recall basics of DNA sequencing 4. Demonstrate next generation sequencing topics 5. Discover the practical aspect of sequencing 6. Apply informatics needed for NGS instrument handling 7. Interpret NGS data
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Brown, S.M. (2013). *Next-generation DNA sequencing informatics, 1st ed*. Cold Spring Harbor, NY, USA: Cold Spring Harbor Laboratory Press.
Recommended Literature	Marco, D. (2010). *Metagenomics: Theory, methods, and applications*. Norfolk, UK: Caister 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 credits (total workload / 25)			6

Course Code: GBE 608	**Course Name:** MEDICAL GENETICS		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Doctorate students have an opportunity to get familiar with medical genetics by choosing it as an elective course. The course mainly explains the role of medical genetics in the diagnosis and management of hereditary diseases. Apart from that, an overview of practical application of medical genetics in the fields such as pharmacogenetics, immunogenetics, and cancer genetics is given to the graduates. Finally, genetic counseling and ethical issues are studied as an important aspect of the course. Through this course, graduates will also repeat the basics of genetics, cell biology, and human inheritance patterns.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Repeating the basics of genetics and inheritance patterns. ● Explaining the application of genetics in medicine. ● Giving an overview of various aspects of clinical genetics.		
Course Content	● The history and impact of genetics in medicine; cellular and molecular basis of inheritance ● Cytogenetics ● Inheritance patterns ● Polygenetic and multifactorial genetics ● Genetics in medicine: An overview ● Hemoglobin and hemoglobinopathy ● Biochemical genetics ● MID-TERM EXAM	● Pharmacogenetics ● Immunogenetics ● Cancer genetics ● Genetic factors in common diseases ● Clinical genetics: Chromosomal disorders and single-gene disorders ● Genetic counseling ● Ethical issues ● FINAL EXAM	
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 basics of genetics and various inheritance patterns 2. Recall Mendelian and non Mendelian genetics 3. Recall pedigree analysis 4. Recognize single gene disorders 5. Examine cancer genetics 6. Review the application of genetics in medicine
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Turnpenny, P.D. & Ellard, S. (2011). *Emery's elements of medical genetics, 14th ed*. London, UK: Churchill Livingstone.
Recommended Literature	Gunder McClary, L.M. & Martin, S.A. (2010). *Essentials of Medical Genetics for Health Professionals, 1st ed*. Burlington, MA, USA: Jones & Bartlett Learning.

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 credits (total workload / 25)			6

Course Code: GBE 609	**Course Name:** BIOLOGICAL SIGNAL TRANSDUCTION		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course covers the fundamental process that is occurring within the living cell – signal transduction or cell signaling. After giving an overview of biochemical principles important for signaling cascades, the interest is put on signaling molecules and receptors. Actually, the major part of the course is related to the study of different classes of receptors existing either inside or outside of the cell. The course will also introduce students to a variety of signal transduction pathways and their function in the regulation of cellular processes. Special emphasis will be given to the evolution of signaling molecules and cascades.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Explaining the basics of signal transduction and the chemistry of signaling. ● Explaining the concept of receptors and effectors. ● Illustrating various signal transduction pathways.		
Course Content	● Basic biochemistry of signal transduction ● Molecular mechanisms of signaling and cell communication ● Signaling molecules: First messengers ● Second messenger system; Calcium signaling: Receptors and effectors ● Classes of receptors: Extracellular and intracellular receptors ● Structure and mechanisms of cell surface receptors ● Extracellular receptors: GTP-binding proteins and signal transduction ● MID-TERM EXAM ● Extracellular receptors: Ion channels, JAK kinases ● Signaling pathways operated by receptor protein tyrosine kinase ● Intracellular receptor model and cellular responses ● Adhesion molecules in the regulation of cell differentiation ● Cell proliferation signaling pathway ● An overview of the major pathways ● Evolution of signal mechanisms ● FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 the basic biochemistry of signal transduction 2. Illustrate the basics of cell signaling and signal transduction mechanisms 3. Analyze various signal transduction pathways 4. Discuss the practical approach to analyzing signaling transduction pathways 5. Recall basic terminology in signal transduction: signal transduction mechanisms, different signaling pathways, membrane receptors, second messengers, cell cycle regulation, gene transcription, cancer biology and mechanisms of development
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Gomperts, B.D., Kramer, I.M. & Tatham, P.E.R. (2003). *Signal transduction, 1st ed*. Waltham, MA, USA: Academic Press.
Recommended Literature	Sitaramayya, A. (2009). *Signal transduction: Pathways, mechanisms, and diseases.* New York City, NY, USA: Springer. Pickens, C.O. (2007). *Cell Apoptotic Signaling Pathways.* Hauppauge, NY, USA: Nova Science Publishers.

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 credits (total workload / 25)			6

Course Code: GBE 610	**Course Name:** COMPUTATIONAL MODELING OF BIOMOLECULES		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course covers a deliberately wide range of topics concerning the study and modeling of biomolecules (DNA, RNA, and proteins) using computer techniques. Methods for structure determination and predictions, the analysis of structure-sequence databases, and the computer-based design of molecules are presented along with approaches for modeling the dynamic behavior of biomolecules and treating complex solvent effects on their structure in solution. Several specific system applications illustrate what can be presently achieved. The graduate student can obtain a good feeling of what is happening in a very active research area at the intersection of molecular biology, physical chemistry, and computer science and obtain valuable information not otherwise easily accessible due to its diversified interdisciplinary character.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to molecular structures. ● Explaining computational approaches to nucleic acid structure. ● Demonstrating rapid conformational investigation of organic molecules		
Course Content	Week 1: Structure, analysis, and prediction Week 2: From sequence similarity to structural homology of proteins Week 3: Equilibrium distribution of secondary structures for large RNA Week 4: Doing sequence analysis by inspecting the order in which neural networks learn Week 5: Computational approaches to nucleic acid structure Week 6: A new program for the analysis of nucleic acid structure: Implications for nucleic acid structure interpretation Week 7: Modeling DNA backbone structures Week 8: MID-TERM EXAM Week 9: Serine and cysteine protease and their natural inhibitors: Structures and implications for function and drug design Week 10: Principles of protein-protein recognition in protease inhibitor and antigen-antibody complexes Week 11: The structures of DNA four way junctions Week 12: Rapid conformational investigation of organic molecules Week 13: Dynamics of DNA oligomers Week 14: Surface boundary conditions: A simulation model for macromolecules Week 15: Computation of ionic distributions and charged biomolecular structure using the PMF approach Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Show basics of drug design 2. Operate basic software needed to conduct modeling of biomolecules 3. Predict DNA structure backbones 4. Practice modeling of proteins 5. Compute ionic distributions and charged biomolecular structure using the PMF approach
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Soumpasis, D.M. & Jovin, T.M. (2011). *Computation of biomolecular structures: Achievements, problems, and perspectives*. New York City, NY, USA: 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 credits (total workload / 25)	6

Course Code: GBE 611	**Course Name:** EMERGING AND REEMERGING PATHOGENS		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	The closing decade of the previous century suggested that infectious diseases will require much more attention from patients and physicians in the 21st century. Recently discovered diseases pose a major threat to the population at large, and the re-emergence of established pathogens has been added to that threat. A large proportion of this problem is man-made, arising mainly from the unnecessary overuse of antimicrobials in hospital and community settings and from the agricultural misuse of the agents in animal feed. A consequence has been a dramatic increase in resistant strains of bacteria that were considered conquerable several decades ago, two examples being methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE). Viruses, such as hantavirus, influenza, and ebola, are also important to be mentioned in this context. Throughout this course, a graduate student is given an opportunity to perform an independent research of emerging and re-emerging pathogens in the 21st century.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Giving an overview of bacterial pathogens that are the major threat in the 21st century. ● Providing an overview of viruses that are major threats in the 21st century. ● Introduction to surveillance and monitoring basics.		
Course Content	Week 1: Introduction to the course Week 2: Severely invasive Group A streptococcal infections Week 3: Bartonella infections in the new century Week 4: Antibiotic-resistant Streptococcus pneumoniae Week 5: MRSA in the 21stcentury Week 6: Vancomycin-resistant enterococci Week 7: Multiresistant Enterobacteriaceae Week 8: MID-TERM EXAM Week 9: Multidrug-resistant tuberculosis Week 10: Cholera Week 11: Drug-resistant malaria Week 12: Influenza Week 13: Ebola Week 14: Hantaviruses Week 15: Controlling and surveillance Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 microbiology terminology 2. Analyze multidrug resistant bacteria that pose a threat to human health 3. Break down antibiotic resistance and its importance in the spread of emerging and reemerging pathogens 4. Categorize viruses that are a threat in the 21st century 5. Debate the importance and implications of monitoring and surveillance of emerging and reemerging pathogens
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Fong, I.W. & Drlica, K. (2003). *Reemergence of established pathogens in the 21st century*. New York City, NY, USA: Springer.
Recommended Literature	Relevant scientific articles

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 credits (total workload / 25)			6

Course Code: GBE 612	**Course Name:** MOLECULAR DIAGNOSTICS IN MICROBIOLOGY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	The ability to control infections is largely dependent on the ability to detect aetiological agents in the clinical microbiology laboratory. Molecular diagnostics in microbiology consists of two main components, identification and typing. The usage of these tests as a routine in microbiology laboratories has started with the discovery of PCR in the late 1980s. Presently, molecular biology offers a wide repertoire of techniques and permutations of different analytical tools. Therefore, this course aims to explore the application of molecular biology techniques in diagnostic microbiology laboratory settings, with a special emphasis put on the current situation in Bosnia and Herzegovina.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing an overview of all the molecular diagnostic techniques used in B&H hospitals. ● Demonstrating how to operate various machines. ● Explaining how to interpret results.		
Course Content	Week 1: Introduction to molecular diagnostics Week 2: Vitek® Week 3: ELISA: Functioning mechanism Week 4: ELISA: Detection of various viral antibodies Week 5: Bacterial DNA isolation Week 6: Viral DNA/RNA isolation Week 7: Real-time PCR in clinical settings Week 8: MID-TERM EXAM Week 9: Genotyping of M. tuberculosis by hybridization on HAIN Week 10: Detection of antibiotic sensitivity by hybridization on HAIN Week 11: Detection of viruses by DNA amplification via thermocycler and running on gel electrophoresis Week 12: Interpretation of electrophoresis results Week 13: Testing of autoimmune diseases Week 14: Genotyping Week 15: Overview of all methodologies and further developments within the field Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Isolate and amplify bacterial and viral DNA/RNA 2. Analyze the obtained results on real time PCR 3. Perform hybridization on hain and analyze the obtained results 4. Perform ELISA testing 5. Perform bacterial identification on Vitek
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Busby, S.J.W., Thomas, C.M. & Brown, N.L. (1998). *Molecular microbiology, 1st ed.* New York City, NY, USA: Springer.
Recommended Literature	Relevant scientific articles

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 credits (total workload / 25)	6

Course Code: GBE 613	**Course Name:** ANTIMICROBIAL RESISTANCE		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Antimicrobial resistance is recognized as a growing global threat. It threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses, and fungi. Antimicrobial resistance is present in all parts of the world since the new resistance mechanisms emerge and spread globally. Through this course, graduate students will get an overview of the main groups of antibiotics and the molecular mechanisms of their antibiotic resistance development. An overview of the current situation in clinical centers in Bosnia and Herzegovina is given at the end of the module, along with recommendations for prevention of the development of antibiotic resistance.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Listing the basic groups of antibiotics. ● Explaining the resistance mechanisms that can be developed for them. ● Introduction to the major healthcare resistance problems.		
Course Content	Week 1: Antibiotics in microbiology Week 2: Cell wall synthesis inhibitors Week 3: Protein synthesis inhibitors Week 4: DNA synthesis inhibitors Week 5: RNA synthesis inhibitors Week 6: Mycolic acid synthesis inhibitors Week 7: Folic acid synthesis inhibitors Week 8: MID-TERM EXAM Week 9: Testing antibiotic sensitivity: Disk diffusion and disk dilution methods Week 10: MRSA Week 11: Extended-spectrum β-lactamases Week 12: Multidrug-resistant tuberculosis Week 13: Molecular mechanisms of antibiotic resistance Week 14: Antibiotic resistance and horizontal gene transfer Week 15: Surveillance Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Clarify antibiotics and their mechanisms of action 2. Categorize the molecular mechanisms that underlay the process of resistance development 3. Compare the basics of MRSA, VRSA, and extended spectrum beta lactamases 4. Test antibiotic resistance 5. Interpret results and local schemes of antibiotic resistance
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Bryan, L. (1984). *Antimicrobial drug resistance*. Orlando, FL, USA: Academic Press, Inc.
Recommended Literature	Walsh, C. (2003). *Antibiotics: Actions, origins, resistance, 1st ed*. Washington, DC, USA: ASM 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 credits (total workload / 25)	6

Course Code: GBE 614	**Course Name:** ADVANCED NEUROENGINEERING		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is based upon the principle of reading reviews and discussions of contemporary and relevant topics by leading investigators in the field. This principles-and-applications approach to neural engineering is essential for all academicians, biomedical engineers, neuroscientists, neurophysiologists, and industry professionals wishing to take advantage of the latest and greatest in this emerging field. The course revolves around the principles of neural modeling and imaging as the next-generation application of neuroengineering for the 21st century.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Demonstrating the nerve cell and tissue. ● Giving an overview of the basic concepts of neurophysiology. ● Explaining neural modelling. ● Explaining neural tissue engineering.		
Course Content	Week 1: Introduction to neurophysiology Week 2: Brain computer interfaces Week 3: Neurorobotics Week 4: Decoding algorithms for brain-machine interfaces Week 5: Neural modeling Week 6: Neural modeling: Application Week 7: Bidomain modeling of neural tissue Week 8: MID-TERM EXAM Week 9: Transcranial magnetic stimulation Week 10: Managing neurological disorders using neuromodulation Week 11: Functional magnetic resonance imaging Week 12: Electrophysiological mapping and neuroimaging Week 13: Exploring functional and casual connectivity in the brain Week 14: Neural interfacing with the peripheral nervous system Week 15: Neural tissue engineering Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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 nerve cells and tissues 2. Outline the basic concepts of neurophysiology 3. Have an integrated approach to the neural-machine interface 4. Conduct neural modeling 5. Divide the newest approaches to neuroengineering
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	DiLorenzo, D.J. & Bronzino, J.D. (2007). *Neuroengineering, 1st ed*. Boca Raton, FL, USA: 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 credits (total workload / 25)	6

Course Code: GBE 615	**Course Name:** EXPERIMENTAL TECHNIQUES IN MOLECULAR BIOLOGY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course is designed in a way to offer theoretical explanation of the advanced techniques used in molecular biology. The major part of the course is related to the protein isolation, purification, and analysis. The most important analytical techniques explored during the course are different electrophoretic methods, chromatography techniques, and immunoassays. Special attention is devoted to the study of both monoclonal and polyclonal antibody preparation and production.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Revising basic molecular techniques needed in the laboratory. ● Explaining how to get valid results. ● Explaining how to interpret obtained results.		
Course Content	Week 1: Historical overview of the development of molecular biology and techniques Week 2: gDNA and mtDNA isolation; troubleshooting Week 3: RNA isolation; isolation of specific RNA molecules; troubleshooting Week 4: Protein isolation Week 5: Chromatographic techniques Week 6: Spectrophotometry Week 7: ELISA Week 8: MIDERM EXAM Week 9: PCR-based techniques Week 10: Electrophoresis: agarose, PAGE, capillary electrophoresis Week 11: FISH and hybridization Week 12: Northern, Western and Southern blot Week 13: NGS techniques Week 14: Microarray Week 15: Cell culture Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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. Test the basic techniques in molecular biology needed to do their thesis in genetics and bioengineering 2. Apply knowledge from molecular biology to develop a profound understanding of the applied techniques 3. Interpret results obtained through these analyses
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Rosenberg, I.M. (2004). *Protein analysis and purification: Benchtop techniques, 2nd ed.* Berlin, Germany: Birkhauser.
Recommended Literature	Al-Rubeai, M. (2011). *Antibody expression and production (Cell engineering).* New York City, NY, USA: Springer. Davis, L.G, Kuehl, M. & Battey, J.F. (1995). *Basic methods in molecular biology, 2nded*. New York City, NY, USA: McGraw-Hill Professional.

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 credits (total workload / 25)			6

Course Code: GBE 616	**Course Name:** ADVANCED BIOCHEMISTRY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course thoroughly explains advanced biochemical concepts while offering a unified presentation of life and its variation through evolution. Both classical and current research is incorporated to illustrate the complexity of biochemistry of life processes. The first part of the course is designed in a way to cover selected topics by reading about them in the classical sources. In the second part of the course, the remaining topics are covered by reading recently published high quality papers that will give a contemporary view on advanced biochemistry.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing a detailed description of the basics of biochemistry. ● Reviewing thermodynamics, protein folding, signaling processes, as well as metabolism and energy topics. ● Examining chosen articles on related subjects of biochemistry.		
Course Content	Week 1: Introduction to the course Week 2: Water, pH, and ionic equilibrium Week 3: Thermodynamics of biological systems Week 4: Protein folding, dynamics, and structural evolution Week 5: Signal transduction Week 6: Transport through membranes Week 7: Energy metabolism Week 8: MID-TERM EXAM Week 9: Metabolic homeostasis Week 10: Analysis of a research article: Proteins and hormones Week 11: Analysis of a research article: GPCRs and G-protein activation Week 12: Analysis of a research article: Enzymology Week 13: Analysis of a research article: Glucose metabolism and cancer Week 14: Analysis of a research article: Biochemistry of retroviral integration Week 15: Analysis of a research article: Functional Genomics Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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	The knowledge, abilities and attitudes that the student will develop through this course are: 1. Basic knowledge of biochemistry 2. The application of that knowledge in various fields 3. Research article analysis
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Harwood, R. (2002). *Biochemistry (Cambridge advanced sciences).* Cambridge, UK: Cambridge University Press.
Recommended Literature	Berg, J.M., Tymoczko, J.L. & Stryer, L. (2006). *Biochemistry, 6th ed.* London, UK: W. H. Freeman. Relevant scientific articles

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 credits (total workload / 25)			6

Course Code: GBE 617	**Course Name:** ENVIRONMENTAL MICROBIOLOGY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This course gives a comprehensive and up-to-date discussion of environmental microbiology as a discipline that has grown in scope and interest in recent years. From environmental science and microbial ecology to topics in molecular genetics, this course relates environmental microbiology to different areas of life science. After examining microbial species present in the soil, air, water, and extreme environments, graduates are given an opportunity to pass through the most important methods for species cultivation and identification. The course is concluded with selected topics related to the role microbes play in natural ecosystems. Graduates taking the course are urged to independently research and express their views on the topics elaborated throughout the course.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Introduction to the microbial characteristics and their growth curves. ● Explaining microbes in different ecosystems. ● Teaching various detection methods.		
Course Content	Week 1: Introduction to environmental microbiology Week 2: Microorganisms and bacterial growth Week 3: Soil environments Week 4: Aeromicrobiology Week 5: Aquatic environments Week 6: Extreme environments Week 7: Environmental sample collection and processing Week 8: MID-TERM EXAM Week 9: Microscopic techniques Week 10: Cultural methods Week 11: Physiological methods Week 12: Immunological methods Week 13: Nucleic acid-based methods of analysis Week 14: Biogeochemical cycling and microbial communication: Bacteria-bacteria and bacteria-host Week 15: Bacterial communities in natural ecosystems Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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	On successful completion of this course, graduates should be able to: 1. Recall basic terminology about microorganisms 2. Categorize microbes in aquatic and other ecosystems 3. Explain bacterial communication 4. Manage various bacterial detection methods 5. Construct microbial growth curves
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Pepper, I.L., Gerba, C.P., Gentry, T.J. & Maier, R.M. (2008). *Environmental microbiology*, *2nd ed.* Waltham, MA, USA: Academic 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 credits (total workload / 25)	6

Course Code: GBE 618	**Course Name:** BIOMEDICAL IMAGING		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	This is an advanced course introducing the theory of imaging methods in medicine. Therefore, a short introduction concerning physical principles of biomedical imaging is given, followed by an overview of historical methods. Medical imaging systems to be analyzed during the course include conventional X-ray radiography, computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine (PET and SPECT), and ultrasound imaging. Also, students are expected to read relevant scientific articles in order to better understand how biomedical imaging techniques function and what are the future perspectives in the field.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Listing different methods and modalities used for medical imaging. ● Explaining the preferred medical imaging methods for routine clinical applications. ● Explaining the engineering models used to describe and analyze medical images. ● Teaching graduates how to apply these tools to different problems in medical imaging.		
Course Content	Week 1: Introduction to the course Week 2: History of cross-sectional medical imaging Week 3: Basic concepts and physics of radiation-matter interaction Week 4: X-ray radiography and computed tomography (CT) Week 5: Article analysis Week 6: Nuclear medicine Week 7: Single photon emission computed tomography (SPECT) and positron emission tomography (PET) Week 8: MID-TERM EXAM Week 9: Article analysis Week 10: Magnetic resonance imaging Week 11: Article analysis Week 12: Reconstruction from projections Week 13: Article analysis Week 14: Ultrasound imaging Week 15: Article analysis Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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	On successful completion of this course, graduates should be able to: 1. Recall the basics of medical imaging 2. Summarize X-ray, ultrasound and magnetic resonance imaging 3. Analyze research articles 4. Describe and analyze medical images 5. Apply engineering models to different problems in medical imaging
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Smith, N.B. & Webb, A. (2010). *Introduction to medical imaging: Physics, engineering and clinical applications, 1st ed.* Cambridge, UK: 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	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 credits (total workload / 25)	6

Course Code: GBE 619	**Course Name:** ADVANCED TOPICS IN NEUROGENETICS		
Level: PhD	**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 chance to get familiar with neurogenetics and neurodegenerative diseases as they relate to classical genetics principles. After introductory lectures on the basics of neurology, classical examples of neurogenetic conditions are studied one by one in order to enable graduates to gain a deep understanding of this field of science. The course is concluded by analyzing relevant scientific papers in order to understand modern approaches in neurogenetics and to get even better understanding of its nature.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Presenting the most current breakthroughs in neurogenetic disease from both clinical and scientific perspectives. ● Describing modern approaches to genetic testing. ● Providing in-depth chapters on genetic neurological disorders, with applications of modern knowledge to clinical evaluation and the understanding of disease mechanisms. ● Reviewing available neurogenetic data and discussing how it can be utilized and applied using practical examples.		
Course Content	Week 1: Introduction to the course Week 2: Central nervous system and peripheral nervous system Week 3: Genetic factors in the development of nervous system Week 4: Neurogenetic diseases Week 5: Modern approaches to neurogenetic conditions Week 6: Inherited neuropathies Week 7: Duchenne/Becker muscular dystrophy; limb-girdle muscular dystrophy Week 8: MID-TERM EXAM Week 9: Spinal muscular atrophy; hereditary spastic paraplegia Week 10: Huntington's disease; Wilson's disease Week 11: Inherited epilepsies Week 12: Mitochondrial disorders Week 13. Genetic forms of common neurodegenerative diseases; Parkinson's disease and Alzheimer's disease Week 14: Ethical dilemmas Week 15: Analyzing relevant scientific articles Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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	On successful completion of this course, graduates should be able to: 1. Argue modern approaches to neurogenetic conditions 2. Assess genetic testing and counseling 3. Compare neurogenetic diseases and their genetic forms 4. Examine non-genetic neurological illnesses 5. Demonstrate the application of genetic methods in disease determination
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Lynch, D.R. (2005). *Neurogenetics: Scientific and clinical advances, 1st ed.* Boca Raton, FL, USA: CRC Press
Recommended Literature	Relevant scientific articles

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 credits (total workload / 25)	6

Course Code: GBE 620	**Course Name:** ADVANCED TOPICS IN MOLECULAR FORENSIC GENETICS AND ANTHROPOLOGY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	During this course, graduates are expected to grasp the basic terms and methods related to the field of molecular forensic anthropology. In order to successfully complete the course, they should be able to understand the ways of analysis of human skeletal and dental remains in order to identify one's age-at-death, sex, race, and stature. Additionally, graduates should be able to put the role of forensic anthropologist into the broader context of police investigations that include the analysis of human remains with the ultimate goal of reconstructing person's identity. Finally, students are preparing their presentations on a given topic twice during the semester.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Comprehending basics of physical and molecular anthropology. ● Application of advanced anthropological and genetics knowledge in forensic matters. ● Understanding of advanced molecular techniques used in forensic genetics and anthropology. ● Analysis of scientific studies and articles in the field of forensic genetics and forensic molecular anthropology.		
Course Content	Week 1: Introduction to forensic anthropology Week 2: The basic osteology of the human body and dental analysis Week 3: The human skeleton: Determination of age-at-death and gender Week 4: The human skeleton: Race determination Week 5: The human skeleton: Stature determination Week 6: Reconstructing identity Week 7: Student presentations Week 8: MID-TERM EXAM Week 9: Forensic aspects of mtDNA analysis and Y chromosome in forensic science Week 10: Forensic application of X-chromosome STRs and SNPs Week 11: Low copy number DNA profiling; Forensic DNA mixtures, approaches, and analysis Week 12: Identification by DNA and identification of missing persons and mass disaster victims Week 13: Forensic tissue identification with nucleic acids; Evolving technologies in forensic DNA analysis Week 14: Prediction of physical characteristics, such as eye, hair, and skin color, based solely on DNA Week 15: DNA in immigration and human trafficking and DNA databanking Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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	On successful completion of this course, graduates should be able to: 1. Create individual profile for human skeleton using classical and molecular anthropology methods 2. Gain advanced knowledge in latest forensic genetics and usage of all sorts of forensic and genetic analysis methods in processing human, animal and plant biological trace samples 3. Collect forensic samples for forensic analysis 4. Grasp basic bio statistical principles in forensic genetics and molecular forensic anthropology
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Byers SN (2010). *Introduction to Forensic Anthropology*. London, England: Routledge.
Recommended Literature	Primorac, D. & Schanfield, M. (2014). *Forensic DNA applications: An interdisciplinary perspective.* 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
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 credits (total workload / 25)	6

Course Code: GBE 621	**Course Name:** EXPLORING POPULAR MISCONCEPTIONS OF MODERN BIOTECHNOLOGY		
Level: PhD	**Year:** I	**Semester:** I,II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3+0		**Total Hours:** 45+0
Course Description	Over the past two decades, modern biotechnology has been making a huge impact on humanity. Advances in information accessibility lead to higher demands by general public with regards to the understanding of potential applications. Unfortunately, sources of information are frequently not relevant and lead to wrong interpretation of concepts and estimation of potential hazards. During this course, the graduates will be given basic information on current hot topics in modern biotechnology which they will use to identify and deconstruct prevailing misconceptions.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Teaching how to avoid pseudoscience through article reading and discussions. ● Explaining how to make your own opinion based on scientific facts. ● Revising basic concepts in the various fields of biotechnology.		
Course Content	Week 1: Introduction to the course Week 2: Research applications of biotechnology Week 3: Healthcare applications (vaccines and regenerative medicine) Week 4: Crop biotechnology Week 5: Crop biotechnology: Discussion Week 6: Animal biotechnology Week 7: Animal biotechnology: Discussion Week 8: MID-TERM EXAM Week 9: Food biotechnology Week 10: Food biotechnology: Discussion Week 11: Biofuels Week 12: Green technology Week 13: Biofuels and green technology: Discussion Week 14: Student presentations Week 15: Student debate Week 16: FINAL EXAM		
Teaching Methods Description	● Interactive lectures and communication with students ● Discussions ● Student 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	On successful completion of this course, graduates should be able to: 1. Recognize misinterpretation of scientific concepts 2. Follow up on the source of misinterpretation 3. Research and gather correct information and prepare proper interpretation using substantiated facts 4. Deconstruct misconception 5. Actively participate in courses and take responsibility for learning 6. Begin to work effectively as part of a team, developing interpersonal, organizational and problem-solving skills within a managed environment 7. Present information in oral, written or graphic forms in order to communicate effectively with peers and tutors
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	Guilford-Blake, R. & Strickland, D. (2008). *Guide to biotechnology.* Washington, DC, USA: Biotechnology Industry Organization.
Recommended Literature	Relevant scientific articles

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 credits (total workload / 25)	6

Course Code: GBE 693	**Course Name:** SEMINAR I		
Level: PhD	**Year:** I	**Semester:** I	**ECTS Credits:** 6
Status: Compulsory	**Hours/Week:** 0+3		**Total Hours:** 0+45
Course Description	This course is divided into two parts. The first part is designed to teach students how to get full advantage of scientific databases and how to find needed scientific articles. Also, the course gives instructions on how to properly understand, analyze, and discuss scientific paper. Finally, graduates are doing a detailed literature review in order to identify their field of interest in which they want to realize their doctoral dissertations and pursue their academic careers. The course is performed under assistance of student's mentor/supervisor.		
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 and academic writing, ● Explaining the synthesis, integration, and application of concepts and principles acquired.		
Course Content	● Getting familiar with the usage of scientific databases. ● Learning how to analyze and discuss scientific paper. ● Identifying study areas of interest. ● Identifying an appropriate graduate project in the field of interest. ● Obtaining approval from the advisor to conduct graduate project in the field of interest.		
Teaching Methods Description	● Consultations ● Professor-graduate communication ● Literature analysis		

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 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)	None
Language of Instruction	English
Mandatory Literature	Textbook choice depends on 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, 1st ed.* Weinheim, Germany: Wiley-VCH. ● Evans, D., Gruba, P. & Zobel, J. (2012). *How to write a better thesis, 3rded*. Melbourne, Australia: Melbourne University Publishing. ● Rugg, G. (2010). *The unwritten rules of PhD research, 2nd ed*. Maidenhead, Berkshire, UK: Open University Press. ● Locke, L.F., Spirduso, W.W. & Silverman, S. (2013). *Proposals that work: A guide for planning dissertations and grant proposals, 6th ed*. Thousand Oaks, CA, USA: SAGE Publications, Inc.

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 (including defense)	1	40	40
Total workload			150
ECTS credits (total workload / 25)			6

Course Code: GBE 694	**Course Name:** SEMINAR II		
Level: PhD	**Year:** I	**Semester:** II	**ECTS Credits:** 6
Status: Compulsory	**Hours/Week:** 0+3		**Total Hours:** 0+45
Course Description	This course is divided into two parts. The second part of the 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 and academic writing. ● Explaining the synthesis, integration, and application of concepts and principles acquired.		
Course Content	● 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	● Consultations ● Professor-graduate communication ● Literature analysis		

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 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)	None
Language of Instruction	English
Mandatory Literature	Textbook choice depends on 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, 1st ed.* Weinheim, Germany: Wiley-VCH. ● Evans, D., Gruba, P. & Zobel, J. (2012). *How to write a better thesis, 3rd ed*. Melbourne, Australia: Melbourne University Publishing. ● Rugg, G. (2010). *The unwritten rules of PhD research, 2nd ed*. Maidenhead, Berkshire, UK: Open University Press. ● Locke, L.F., Spirduso, W.W. & Silverman, S. (2013). *Proposals that work: A guide for planning dissertations and grant proposals, 6th ed*. Thousand Oaks, CA, USA: SAGE Publications, Inc.

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 (including defense)	1	40	40
Total workload			150
ECTS credits (total workload / 25)			6

Course Code: GBE 695	**Course Name:** PhD DISSERTATION I		
Level: PhD	**Year:** II	**Semester:** III	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0+0		**Total Hours:** 0+0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing and outline of how to perform a literature review. ● Explaining the scientific approach to research questions. ● Teaching how to carry out a scientific study and appropriately manage its data. ● Giving an overview of ethics involved in animal and/or human research. ● Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	● Reviewing literature related to the dissertation topic. ● 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. ● Preparing and publishing scientific papers in distinguished scientific journals. ● Writing a PhD dissertation in which the major findings of the research will be presented and compared to the previously published literature. ● Defending PhD dissertation in the form of oral presentation.		
Teaching Methods Description	● Literature review ● Experimental research ● Supervisor-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 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)	None
Language of Instruction	English
Mandatory Literature	Textbook choice depends on 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, 1st ed.* Weinheim, Germany: Wiley-VCH. Evans, D., Gruba, P. & Zobel, J. (2012). *How to write a better thesis, 3rd ed.* Melbourne, Australia: Melbourne University Publishing. Rugg, G. (2010). *The unwritten rules of PhD research, 2nd ed.* Maidenhead, Berkshire, UK: Open University Press. Locke, L.F., Spirduso, W.W. & Silverman, S. (2013). *Proposals that work: A guide for planning dissertations and grant proposals, 6th ed.* Thousand Oaks, CA, USA: SAGE Publications, Inc.

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
Data analysis and reporting	1	150	150
Thesis writing process	1	100	100
Seminar / Presentation (including defense)	1	100	100
Total workload			750
ECTS credits (total workload / 25)			30

Course Code: GBE 696	**Course Name:** PhD DISSERTATION II		
Level: PhD	**Year:** II	**Semester:** IV	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0+0		**Total Hours:** 0+0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing and outline of how to perform a literature review. ● Explaining the scientific approach to research questions. ● Teaching how to carry out a scientific study and appropriately manage its data. ● Giving an overview of ethics involved in animal and/or human research. ● Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	● Reviewing literature related to the dissertation topic. ● 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. ● Preparing and publishing scientific papers in distinguished scientific journals. ● Writing a PhD dissertation in which the major findings of the research will be presented and compared to the previously published literature. ● Defending PhD dissertation in the form of oral presentation		
Teaching Methods Description	● Literature review ● Experimental research ● Supervisor-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 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)	None
Language of Instruction	English
Mandatory Literature	Textbook choice depends on 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, 1st ed.* Weinheim, Germany: Wiley-VCH. Evans, D., Gruba, P. & Zobel, J. (2012). *How to write a better thesis, 3rd ed.* Melbourne, Australia: Melbourne University Publishing. Rugg, G. (2010). *The unwritten rules of PhD research, 2nd ed.* Maidenhead, Berkshire, UK: Open University Press. Locke, L.F., Spirduso, W.W. & Silverman, S. (2013). *Proposals that work: A guide for planning dissertations and grant proposals, 6th ed.* Thousand Oaks, CA, USA: SAGE Publications, Inc.

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
Data analysis and reporting	1	150	150
Thesis writing process	1	100	100
Seminar / Presentation (including defense)	1	100	100
Total workload			750
ECTS credits (total workload / 25)			30

Course Code: GBE 697	**Course Name:** PhD DISSERTATION III		
Level: PhD	**Year:** III	**Semester:** V	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0+0		**Total Hours:** 0+0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing and outline of how to perform a literature review. ● Explaining the scientific approach to research questions. ● Teaching how to carry out a scientific study and appropriately manage its data. ● Giving an overview of ethics involved in animal and/or human research. ● Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	● Reviewing literature related to the dissertation topic. ● 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. ● Preparing and publishing scientific papers in distinguished scientific journals. ● Writing a PhD dissertation in which the major findings of the research will be presented and compared to the previously published literature. ● Defending PhD dissertation in the form of oral presentation		
Teaching Methods Description	● Literature review ● Experimental research ● Supervisor-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 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)	None
Language of Instruction	English
Mandatory Literature	Textbook choice depends on 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, 1st ed.* Weinheim, Germany: Wiley-VCH. Evans, D., Gruba, P. & Zobel, J. (2012). *How to write a better thesis, 3rd ed.* Melbourne, Australia: Melbourne University Publishing. Rugg, G. (2010). *The unwritten rules of PhD research, 2nd ed.* Maidenhead, Berkshire, UK: Open University Press. Locke, L.F., Spirduso, W.W. & Silverman, S. (2013). *Proposals that work: A guide for planning dissertations and grant proposals, 6th ed.* Thousand Oaks, CA, USA: SAGE Publications, Inc.

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
Data analysis and reporting	1	150	150
Thesis writing process	1	100	100
Seminar / Presentation (including defense)	1	100	100
Total workload			750
ECTS credits (total workload / 25)			30

Course Code: GBE 698	**Course Name:** PhD DISSERTATION IV		
Level: PhD	**Year:** III	**Semester:** VI	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0+0		**Total Hours:** 0+0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the genetics and bioengineering methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: ● Providing and outline of how to perform a literature review. ● Explaining the scientific approach to research questions. ● Teaching how to carry out a scientific study and appropriately manage its data. ● Giving an overview of ethics involved in animal and/or human research. ● Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	● Reviewing literature related to the dissertation topic. ● 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. ● Preparing and publishing scientific papers in distinguished scientific journals. ● Writing a PhD dissertation in which the major findings of the research will be presented and compared to the previously published literature. ● Defending PhD dissertation in the form of oral presentation		
Teaching Methods Description	● Literature review ● Experimental research ● Supervisor-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 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)	None
Language of Instruction	English
Mandatory Literature	Textbook choice depends on 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, 1st ed.* Weinheim, Germany: Wiley-VCH. Evans, D., Gruba, P. & Zobel, J. (2012). *How to write a better thesis, 3rd ed.* Melbourne, Australia: Melbourne University Publishing. Rugg, G. (2010). *The unwritten rules of PhD research, 2nd ed.* Maidenhead, Berkshire, UK: Open University Press. Locke, L.F., Spirduso, W.W. & Silverman, S. (2013). *Proposals that work: A guide for planning dissertations and grant proposals, 6th ed.* Thousand Oaks, CA, USA: SAGE Publications, Inc.

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
Data analysis and reporting	1	150	150
Thesis writing process	1	100	100
Seminar / Presentation (including defense)	1	100	100
Total workload			750
ECTS credits (total workload / 25)			30