Course unit (module) title	Code
Essential Concepts of Biology	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Erinija Pranckevičienė, PhD, **Others: Eglė Mazgelytė**	Department of Human and Medical Genetics, Faculty of Medicine, Vilnius University Santariskiu str. 2, LT-08661

Study cycle	Type of the course unit (module)
Second cycle	Elective

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face, self-study Lectures, seminars and practice	1st semester	English

Requirements for students	
Prerequisites: High school biology	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	136	68	68

Purpose of the course unit (module): programme competences to be developed

This course is intended for students with technical-mathematical background. It aims to present essential concepts of biology and methodologies in a compact form. Students will acquire knowledge about a scope and context of the areas in which systems biology is applied. Students will develop basic observational and bio-skills, attain necessary knowledge in modern ecology, evolution, biodiversity, animal and plant form and function and reproduction, composition of the living matter, levels of organization in living systems, development of organisms and their interaction with environment, principles of energy and information exchange in living systems at the macro and molecular levels. Students will develop skills to understand and interpret outputs of experimental techniques that are used to study living systems. Students will develop an advanced understanding of biology necessary to follow higher level courses in systems biology program.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
1.1 acquisition of essential knowledge of biology on macro and molecular levels, diversification of life, evolution and ecology, and attaining of understanding of the biological context and areas in which systems biology is exercised.	Lectures, practical assignments	Completion of practical assignments (two midterm tests)
2.1 ability to explain and upon the need to reproduce results published in scientific literature on biological topics.	Debates and group discussions, practical assignments	Seminar presentation of recent scientific findings in literature on a selected topic; written examination.
3.1, 3.2 ability to apply molecular experimental and computational techniques to study various aspects of living systems and their functions; Ability to prepare and design an assay.	Lectures, group discussions, practical assignments	Completion of practical assignments, course work to design a practical assay for a selected analysis problem of biological data

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**
1. **Biology: The Study of Life.** Introductory lecture. Life is cellular and replicates through cell division. Life processes information and requires energy. Life evolves. The "Tree of Life" depicts evolutionary history. "Doing biology".	2						2	2	BS Freeman Chapter 1 To be specified **EP**
2. **Evolution by natural selection.** The Rise of Evolutionary Thought: Darwin and Wallace. The Pattern of evolution: have species changed and are they related? The process of evolution: how natural selection works? Measuring natural selection in populations today. Evolutionary processes: gene pool concept, nonrandom mating, natural selection, genetic drift, gene flow, mutation.	2			2			4	4	BS Freeman Chapters 22-23 T. Brown Ch16,18. A.Lesk Ch4. X.Xia 2007. To be specified **EP**
3. **Speciation.** Phylogenies and history of life. Tools for studying Life's history -phylogenetic trees and fossil record. Large-scale pattern in Life's history: adaptive radiation and mass extinction.	2						2	2	BS Freeman Chapter 25 To be specified **EP**
4. **Diversification of life.** Viruses. Bacteria and Archaea. How do biologists study Bacteria and Archaea- using metagenomics. Themes that occurr in studying diversification of Bacteria and Archaea: gene transfer, morphological, metabolic diversity and ecological diversity and global impact. Diversification of Eukaryotes. How do biologists study protists? Key lineages of Eukaryotes: Amoebozoa, Opisthokonta, Excavata, Plantae, Rhizaria, Alveolata, Stramenophila. Green algae and land plants and how do biologists study them: analyzing morphological traits, using the fossil record, evaluating molecular phylogenies. Key lineages: green algae, nonvascular plants, seedles vascular plants, seed plants gymnosperms and angiosperms. How do biologists study fungi: by morphological traits and molecular phylogenies. Key lineages: microsporidia, Chytrids, Zygomycetes, Glomeromycota, Basidomycota, Ascomycota.	4			4			8	8	BS Freeman Unit5 To be specified **EP**
4. **Inroduction to animals.** Key innovations, origins of: multicellularity, embryonic tissue layers and muscle, bilateral symmetry,	6			6			12	12	BS Freeman Unit5 **EP**

cephalization and nervous system, the gut and coelom, protostomes and deuterostomes, segmentation. Diversification within animal phyla: sensory organs, feeding, movement, reproduction, life cycles. Key lineages of non-bilaterian groups: Porifera (sponges), Ctenophora (Comb Jellies), Cnidaria (Jellyfish, Corals, Anemones, Hydroids). What is protostome animal? The water-to-land transitions. Compartmentalized and flexible body plans. What is Lophotrochozoan? Flatworm, segmented worm and mollusk. What is Ecdysozoan? Roundworm, water bears and velvet worms, arthropods. Deuterostome animals. The Echinoderm body plan. Chordatae: the cephalochordates, the urochordates, the vertebrates. Key innovations in evolution of vertebrates: cranium and vertebrae, vertebrate jaw, bony endoskeleton, the lungs, the limb, the amniotic egg, lactation and fur, scales and feathers made of keratin, parental care. The primates and hominins. Fossil humans. The Out-ofAfrica hypothesis. Have humans stopped evolving?									
5. **Ecology.** Levels of ecology study: organism, population, community, ecosystem, global. Conservation biology applies to all levels of cological study. Distribution and abundance of organisms. Climate patterns. Types of terrestrial and aquatic biomes. Chemical composition of living organisms. Food chains. Cooperation and competition. Population grow and dynamics. Energy and nutrients flow through the ecosystem.	2			2			4	4	BS Freeman Unit6 To be specified **EP**
Colloquium I	2						2		Test
6. **Inside the Cell: a parts list.** Bacterial and Archaeal and Eukaryotic cell structures and functions: The benefits of organelles. Structure and function at the Whole Cell level: the dynamic cell. Nuclear envelope: how the molecules enter nucleus? The endomembrane system manufactures, ships and recycles "cargo". The dynamic cytoskeleton: actin filaments, intermediate filaments, microtubules, flagella and cilia: moving the entire cell.	4			4			8	8	BS Freeman Unit 2 **EM**
7. **Cell processes.** Energy and enzymes: an introduction to metabolism. Cellular respiration and fermentation. Cell-Cell interactions: the cell surfaces; how do adjacent cells connect and communicate? How do distant cells communicate? Signaling between unicellular organisms. The Cell cycle and how do cells replicate? Meiosis and mitosis.	4			4			8	8	J. Watson Ch8. T. Brown Ch15. **EM**
8. **The chemical basis of life.** Atoms, ions and molecules: the building blocks of chemical evolution. Chemical reactions, energy and chemical evolution. Life is carbon based. Carbon provides a molecular skeleton. Functional groups define the chemical behavior of organic molecules.	4			4			8	8	BS Freeman Unit1. J. Watson Ch13, Ch14, Ch15.

Small organic molecules can assemble into large molecules. Introduction to carbohydrates. Lipids, membranes and the first cells. Protein structure and function. Amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Protein folding and function. Nucleic acids and RNA world. The double helix. Genetic information within DNA is in the sequence of its four nucleotide building blocks. The central dogma. Transfer RNA. Messenger RNA. Establishing the genetic code. Direction of protein synthesis. Structure of DNA. Structure and versatility of RNA. Structure of proteins. The genetic code is degenerate. Codon and anti-codon. The genetic code is nearly universal.									T. Brown Ch12. (studying with video material) **EM**
9. **Mendel and the gene.** What questions Mendel was trying to answer? Mendel's experimental system and experiments with a single trait: the monohybrid cross. Experiments with two traits: the dihybrid cross. The testcross to confirm predictions. The chromosome theory of inheritance. Meiosis explains Mendel's principles. Extending Mendel's rules. Are traits determined exclusively by genes? Can Mendel's principles explain traits that don't fall into distinct categories? Applying Mendel's rules to human inheritance.	2			2			4	4	BS Freeman Unit 3, Chapter 14 **EM**
10. **Selected topics.** Photosynthesis. Plant sensory systems, signals and responses. Animal form and function and adaptation. Homeostasis and thermoregulation. Animal reproduction (asexual and sexual), and development. The immune system in animals: innate and adaptive immunity: response and memory.	2			2			4	4	To be specified **EM**
Colloquium II	2						**2**		Test
E. Mazgelytė Total	18			16			**34**		
E. Pranckevičienė Total	20			14			**34**		
Total	**38**			**30**			**68**	**68**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
Self-study assignment	-	every next lecture	Fulfilled/not fulfilled the task
Colloquium I	10%	After topic 5	20 task type questions, 0.05 points each, 1 point total
Colloquium II	10%	After topic 10	20 task type questions, 0.05 points each, 1 point total
Presentation I	20%	mid course	Abstract and presentation of a topic, 2 points
Presentation II	20%	end course	Abstract and presentation of a topic, 2 points
Exam	40%	3 working days after the last class	4 questions, 1 point each, 4 points total

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
S. Freemen, K. Quillin, L.A. Allison, M. Black, G. Podgorski, E. Taylor, J. Carmichael	2020	Biological Science Seventh edition.	ISBN 10:0-134-67832-X	Pearson www.pearson.com
J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick, S.C. Harrison	2014	Molecular biology of the gene	ISBN-13: 978-0-321-76243-6	Cold Spring Harbor Laboratory Press
Optional reading				
T.A. Brown	20017	Genomes 4	ISBN 978-0-81534508-4	Garland Science Publishing, Taylor & Francis Group
X. Xia	2007	Bioinformatics and the cell	ISBN 978-0-387-71337-3	Springer
S. Nowicki author and narrator	2004	Biology: the science of life.	Audible audiobook	The Great Courses No 1500.

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