



COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Developmental biology	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Assoc. prof. Ph. D. Grita Skujienė	Vilnius University, Life Sciences Center, Saulėtekio av. 7, Vilnius.

Study cycle	Type of the course unit (module)
First level	Optional subject

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Auditorial (Face to face)	Autumn	English

Requirements for students	
Prerequisites: a) Vertebrate and Invertebrate zoology, Botany; Genetic; b) Capable of performing standard laboratorial procedures	Additional requirements (if any): Recommendable Evolution theory

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5 VU	133	64	69

Purpose of the course unit (module): programme competences to be developed		
a) to develop fundamental knowledge and skills in areas related to biology, the ability to apply biological research methods; b) to get competences in perception of structure, biology and systematics of principle groups of organisms together with their role in ecosystems and the ability to apply this knowledge in the scientific and practical problems; c) to get competences in perception of the individual and historical development patterns of living things, together with the principles of biological evolution and the ability to apply them in practice; d) perception of the structure and functional characteristics of populations and ecosystems, with the ability to apply it in research and practice; e) to be able to use information and data sources, the use of information technology; f) to develop ability to work independently, communicate and collaborate.		
Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
– Will understand and will be able to explain the physical and chemical basics of living systems; will be able to analyze scientific facts and integrate knowledge from different biological subjects (cytology, genetic, biochemistry, molecular biology and etc.); – Will know structural peculiarities, life cycles, distribution, classification and nomenclature of animal world. - Will percept body structure of algae, fungi, animals and plants, also basics of their functioning and interactions. - Will understand the principles of biological evolution and be able to apply them when solving	Thematic discourses with problem-oriented debatable interpolations. Set of lectures is given with demonstration and description of presentations in PowerPoint and scientific films or their fragments. Elements of investigation (search for information, reading of literature). Practical tasks in laboratory.	Colloquium and exam (test manner).

theoretical and practical problems.		
- Will be able to find appropriate sources of information, distinguish proper information and process it. - Will percept structural and operational features of ecosystems, ecological pyramids, ecological niches and nutrient chains together with the ability to use this knowledge when analyzing and solving biological problems. - Will possess the ability to work both individually and in group, also take responsibility for his/her work.	Research methods (searching of information, reading of literature, multidisciplinary analysis of selected scientific text, preparation for presentation and its making). Group discussions.	PowerPoint presentation. Assessment by teacher and by 5 students (peer review)
- Will understand and will be able to use basic biological research methods. - Will be able to apply biological knowledge and skills in scientific and applied practice; - Will understand the structure and operational peculiarities of the individuals and populations - principal units of life, and will be able to put this knowledge into practice.	Laboratory works: observation of development and regeneration of selected animals. Experiment planning and implementation; observation and comparing of preparates; revision of development films, schematic depiction, comparative analysis of results.	Laboratory course credit (all laboratory works are obligatory) and identification of preparates.

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. Introduction: history and methods of developmental biology. Comparative anatomy (analogies and homologies) and experimental embryology; Fate maps and cell lineages; mathematical modeling, izometric and allometric growing and Turing' activation-diffusion model; genetic labeling and transgenic DNA chimeras.	2				1		3	1	LW: Microscopic techniques. L: Comparison of theories. SS: The Basic Tools of Developmental Genetics: DNA and RNA analysis, Bioinformatics. WEBSITE : 2.1-2.6; 14.1-14.2.
2. When does human personhood begins? The origins of multicellular organism. Metazoa formation. The origins of sexual reproduction (<i>Paramecium</i> sp., <i>Clamydomonas</i> sp.). Between Unicellular and multicellular organism (<i>Volvox</i> sp.; <i>Dictyostellium</i> sp.). Agregation. Cell adhesion. Differentiation. Levels of Commitment.	2				1		3	2	LW. <i>Paramecium</i> . <i>Volvox</i> . <i>D. discoideum</i> life cycles. L: Comparison of reproduction (schema). SS: Textbooks and scientific literature reading, video reviews. WEBSITE : 19.2, 19.5.
3. Gametogenesis. Germ plasm and the determination of the primordial germ cells in model animals. Epigenetic events in mammalian germ cell development. Germ cell migration. Spermatogenesis and ovogenesis: time, periods, place and results. Viteliogenesis. Decision: mitosis or meiosis? Types of gametes, maturation and gene transcription in selected animals. Hormonal regulation of ovulation.	2		1		2		5	4	LW: Spermatogenesis and ovogenesis: comparison. S: Presentations: causes of malfunctions of fertility. Peer review. SS: Scientific literature reading and analysis. WEBSITE : 17.1-17.5.
4. External and internal fertilisation. Etological and biochemical mechanisms of recognition of species and other gender. Mistakes. Importance of socialisation and	2				2		4	2	LW. Study of stages of fertilization of <i>Ascaris</i> sp.. S. Analysis of films „The great sperm race“ 6 parts.

love for mammals reproduction. Interaction between gametes at a distance and in contact. Roles of progesterone in sperm activation and attraction. Fussion of gametes (membranical, citoplazmical, genetical). Preventing of polyspermy. Activation of egg metabolism.									SS. Scientific literature reading and analysis. WEBSITE :4.1-4.6;
5. Cell-cell communication in development. Cell-cell signaling and cascades of induction/transduction. The placement of the Hedgehog pathway onto cilia and the lateral transport of smoothened protein. Interactions of cell surface components and paracrine factors to form morphogen gradients. Juxtacrine signaling. Epithelial-mesenchymal interaction and transition. Maintaining the differentiated state. Roles of the cytoskeleton in localizing receptors for embryonic induction.	2						2	2	L. Review of film: http://www.dnalc.org/resources/animation/s/ SS. Scientific literature reading and analysis. WEBSITE : 3.1-3.4,
6. Mechanisms of control during early development. The Mediator complex and Cohesin in regulating gene transcription. Paused gene transcription. ChiP-Seq methodology and functional chromatin signatures. Nucleosome modeling and DNA methylation status. Poised chromatin. Ribosome-mediated translational specificity. New models of micro-RNA-mediated gene silencing.	2				2		4	2	LW. Life cycle of <i>Drozofila</i> sp. Different types of mutations in polyploidy chromosomes. SS. Scientific literature reading and analysis. WEBSITE :2.7-2.12; 18.1-18.6
Colloquium					2		2	8	SS. Learning for Colloquium
7. Life cycles. Forms and proceeding of development with sexual reproduction: gametogenesis, fertilisation, blastulation, gastrulation, organogenesis, growth (hatch/ birth), growth, metamorphosis), maturation (maturity/ reproduction), aging death. Comparison of the main development stages of animals: sea urchin and bivalve, fly. and snail, bird and mammal, frog and salamander, lancelet and fish.	2						2	2	LW. Comparison of life cycles between Invertebrate and Vertebrate. SS. Scientific literature reading and analysis. WEBSITE : 5-9; SS: Preparation for dispute: Homo/ hetero- sexuality.
8. Sex determination Chromosomal sex determination of mammals, flies and other animals. New mechanisms of X-chromosome inactivation. Ovary and testes determination pathway. Primary and secondary sex determination in mammals. Environmental sex determination (crocodiles, turtles, snakes, <i>Crepidula</i> sp., <i>Bonella</i> sp.): temperature, humidity, chemicals, location.	2		1				3	4	L.: Dispute: Human sexuality, transvestites and etc. – biological, social and ethical problems. SS. Scientific literature reading and analysis. WEBSITE : 15.1-5
9. Early embryonic development of different animals (sea urchin, fly, snail and bivalve, bird, frog, fish, mammal) till gastrulation. Patterns of embryonic cleavage: radial, rotational, spiral, bilateral, discoidal, superficial cleavage. Different types of gastrulation: invagination, involution, ingression, delamination, epiboly. Control of blastomeric identity. Specification of embryonic axes. Segmentation and the posterior-anterior body plan. Maternal gradients. Segments and parasegments.	2				8		10	4	LW: Study of early embryonic development in media and preparates. Provisory organs of embryos. L: Analysis of BBC films „Human development“ . WEBSITE : 10-13.
10. Neurulation and organogenesis of different animals (sea urchin, fly, bird, frog, fish, mammal). The emergens of the ectoderm: Central nervous system and epidermis. Neural crest cells and axonal specifity. Paraxial and intermediate mesoderm. Lateral plate mesoderm and the endoderm.	2				8		10	4	LW. Neurulation and organogenesis of different animals: analysis of preparates and films. SS. Textbooks reading, scientific literature reading, video reviews WEBSITE : 10-13.
11. Postembryonic development: metamorphosis, regeneration, aging and death. Sea urchin, fly, frog metamorphosis in details. Hormonal control: reactivation ir regulation. Biochemical changes. Eversion and	1		1		2		4	4	SS. Scientific literature reading and analysis. WEBSITE : 16.1-16.7.

apoptosis. Planarian neoblasts underlying regeneration. Paracrine signaling centers in planarian and hydra regeneration. Liver regeneration transcriptional network. Aging and maximal duration of the life in mammals and perspectives of their studies. Stem cells and tissue regeneration; Induced pluripotent stem cells. Adult stem cells and regeneration therapy.									SS: Collection of <i>Planaria</i> . Expedition: LW: Studying of regeneration of <i>Planaria</i> . Experiment.
12. Birth defects, endocrine disruptors, cancer. Prenatal diagnostic methods. Cancer as developmental misregulation of paracrine factors. Cancer stem cell hypothesis. Epithelial-to-mesenchymal transition in cancers. Transgenerational endocrine disruption due to germline epigenetic changes. Endocrine disruptors, mesenchymal stem cells, and obesity. Effects of heavy metals and oil spill pollutants on development. Stochastic causes of developmental anomalies. Testicular dysgenesis syndrome and the transgenerational effects of endocrine disruptors. Alcohol, retinoic acid as teratogens. Other teratogen agents.	1		1		2		4	4	LW. Alcohol, retinoic acid and radiation as teratogens for sea urchin and fish development. SS. Scientific literature reading and analysis. WEBSITE: 17.1-17.4 SS: Scientific presentation of article of Development biology. Peer review. SS: Evaluation of students. Questions.
13. Developmental plasticity and symbiosis. The environment as norma lagent in producing phenotypes. Environmental induction of behavioral phenotypes. Life cycles and polyphenisms. Importance of symbionts in the development of the gut and gut stem cell division. Roles of symbionts in mouse behavior. Salamander/algae symbiosis. Mechanisms of developmental plasticity in horned beetles, water fleas, climate change and plasticity. The “holobiont” as a unit of development and selection	2		1				3	4	SS. Textbooks reading, scientific literature reading, video reviews. WEBSITE: 19.1; 19.3; 19.6
14. Developmental mechanisms of evolutionary change. Modularity: divergence through dissociation. Molecular parsimony. Mechanisms of evolutionary changes: heterotopy, heterochrony; heterometry; heterotypy. Developmental constrains on evolution: physical, morphogenetic, phyletic. Selectable epigenetic variation. Evolution via altered Hox gene expression, exemplified by specific Hox changes leading to the limbless state in snakes.	2		1				3	4	SS. Textbooks reading, scientific literature reading, video reviews. WEBSITE: 20.1-20.7
Identification of preparations					2		2	8	SS. Learning for identification.
Exam								10	SS. Learning for exam
Total:	26		6		32		64	69	

Assessment strategy	Weight, %	Deadline	Assessment criteria
Evaluation of PowerPoint Presentation during seminars Implementation of students to assess	25%	During semester	Graded 10-score grading system according VU Study Assessment Procedure. Assessment criteria: 1. Contents (multidisciplinary analysis is comprehensive, the matter is presented understandably and logically, drawing of conclusions is reasonable); 2. Communication (speech is explicit and coherent; contact with auditory is suitable and correct; and full-scale answer to questions is given) 3. Slides (pattern of minds is logic; design is imaginative and interesting but moderated; good citation (even of the pictures);
Evaluation of Colloquium	25%	During semester	Test with answering to the 20 questions in the written form. (assessment criteria like for exam, graded 10-score grading system according VU Study Assessment Procedure)
Evaluation of Laboratory	25%	The end of	Clearing-off for laboratory works (all laboratory works must

works		semester	be finished right, fully, and with good schematic display). + Identification of preparates: 1. Can made identification (2 or more preparations) 2. Can display schematic view and know all structural parts of preparates. Graded 10-score grading system according VU Study Assessment Procedure.
Exam:	25%	During session	Graded 10-score grading system according VU Study Assessment Procedure. Test contain from the 20 questions of open and disputable or multiple choice (majority) questions. Questions can be schematic (from lectures or laboratory works). Assessment of knowledge, argumentation and multidisciplinary (full scale of arguments)) Assessment for questions is in points: totally can get 100 point = 10 score, for good answer to one question not more than 10 points = 1 score. The exam test contain: <u>14 questions from textbook</u> (Gilbert, 2010) and lectures (not more than 60 points) + <u>1 question</u> on free theme of development (not more than 10 points: 1 argument/fact = 1 point) + <u>2 questions</u> from laboratory works (not more than 10 points) + <u>2 questions</u> from self-study web links (not more than 10 points) + <u>1 question</u> from seminar themes links (not more than 10 points).
Accumulation of grade	100%	During session	Graded 10-score grading system according VU Study Assessment Procedure. = I Colloquium (test for the first part) + Presentation (in the oral form) + Identification of preparations + Exam (in the written –test- form)//: 4.

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsary reading				
Gilbert, S.F.	2013.	Developmental Biology.	10th Edition.	Sinauer Associates, Publishers Sunderland, Massachusetts USA. Web link: www.devbio.com
Tyler M.S., Kozlowski Ronald N.	2010.	DevBio Laboratory: vade mecum – An Interactive Guide to Development Biology		Web link: http://labs.devbio.com
Tyler M.S.	2010.	Development Biology: A guide for Experimental Study.	Third edition.	Sinauer Associates, Publishers Sunderland, Massachusetts USA.
Optional reading				
Wolpert L. et al.	2011	Principles of development. (textbook).		Oxford University Press, 616 p.
Robert J.S.	2008	Embryology, Epigenesis and Evolution: Taking Development Seriously.		Cambridge University Press, 128 p.
Stašaitis J.	2008	Vystymosi biologija. (Mokymo priemonė)		VU, 24 p.
Газарян К., Белоусов Л.	1983.	Биология индивидуального развития животных.		Moscow.
In addition: 1. Society for Developmental Biology: http://www.sdbonline.org/ 2. Developmental Biology Interactive: http://www.devbio.biology.gatech.edu/				

[DNA Learning Center](https://www.dnalc.org/resources/animations/) *Preparing students and families to thrive in the gene age:*
<https://www.dnalc.org/resources/animations/>