Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Department of Translational Medical Bioengineering

DEVELOPMENTAL BIOLOGY AND FOUNDATIONS OF EVOLUTIONARY THEORY

Syllabus of the academic discipline (Syllabus)

Academic discipline requirements	
Level of higher education	***First (bachelor's)***
Branch of knowledge	*16 Chemical engineering and Bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Discipline status	*Elective educational components*
Form of study	*full-time / day / mixed / remote*
Year of preparation, semester	*3th course, autumn semester*
The scope of discipline	*4 ECTS credits / 120 hours*
Semester control / Control measures	*Final Test, Module Test Work*
Lessons schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course leader / teachers	***Lecturer:*** *Doctor of Biological Sciences, senior researcher, professor Poyedinok Nataliia* ***Practical:*** *Doctor of Biological Sciences, senior researcher, professor Poyedinok Nataliia*
Course placement	*Platform «Sikorsky»*

Distribution of hours

Semester	Lectures	Practical	Laboratory	Independent Work
autumn semester	*26*	*28*	*0*	*66*

Academic discipline program

1. Description of the academic discipline, its purpose, subject of study and learning outcomes

What will be studied?

For future specialists, it is important to develop the ability to characterize and analyze the patterns of individual development of organisms; to integrate fundamental biological disciplines (cytology and genetics, physiology and biochemistry, ecology) with the synthetic theory of evolution; to form a comprehensive perception of living nature, the place and role of man in it.

Why can you learn?

Knowledge:

- history of anti-evolutionary views, prerequisites and history of creation of evolutionary theory,
- features of the pre-Darwinian period in biology,
- basic provisions of the evolutionary theory of Charles
- Darwin,
  foundations of the modern synthetic theory of evolution,
- general characteristics of elementary evolutionary factors (basics of microevolution),
- basic laws of macroevolution,
- main directions of evolution,
- foundations of biological
  progress,
- foundations of evolution of ontogenesis, organs and
- functions,
  ideas about the development of the organic world of the Earth,
  ideas about ontogenesis and basics of embryology (embionogenesis in humans, structure of reproductive glands, progenesis, early stages of differentiation and cells, organogenesis and systemogenesis),
  critical periods of human development,
- role of hereditary and environmental factors in controlling the growth and development of the organism,
- the role of heredity and environment in the formation human health and diseases,
- methods of studying genetics and heredity in humans.

Learning Outcomes (Skills and Competencies)

Upon successful completion of the course, students will be able to:

- formulate and explain the core principles of the Synthetic Theory of Evolution and justify the logical framework of evolutionary theory;
- describe and analyze the mechanisms of microevolution and macroevolution;
- explain the biological basis of ontogenesis and phylogenesis;
- interpret the molecular and cellular mechanisms involved in the origin and evolution of living organisms.

Application of Knowledge and Skills

The acquired knowledge and skills enable students to identify and analyze relationships between hereditary factors and environmental influences, as well as their impact on human health and disease development. In addition, students will be able to explain evolutionary processes through examples of adaptive mechanisms in contemporary representatives of flora and fauna.

Program Competencies

Upon completion of the course, students will develop program-specific competencies aligned with the educational program **"Biotechnology"**, including the ability to apply evolutionary concepts to biological and biotechnological research.

General Competencies

GC-1 Ability to apply knowledge and understanding in practical situations.
GC-2 Knowledge and understanding of the subject area and awareness of professional activities.
GC-6 Ability to search for, process, and analyze information from various sources.

Professional (Subject-Specific) Competencies

PC-1 Ability to use engineering software packages for conducting research, analyzing, processing, and presenting results, as well as for computer-aided design of medical devices and systems; ability to perform experimental studies aimed at improving biological agents, including inducing changes in the structure of the genetic apparatus and the functional activity of biological agents.

PC-5 Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems.

Program Learning Outcomes

The following program learning outcomes are to be achieved upon successful completion of the course and are aligned with the educational program "Biotechnology":

PLO 1 - Demonstrate knowledge and understanding of the organization and principles of functioning of biological objects and their individual components under *in vivo* and *in vitro* conditions, as well as the biological, chemical, physical, and mathematical methods used for their investigation and evaluation.

PLO 6 - Manage complex activities or projects, assume responsibility for engineering decision-making in unpredictable environments, and perform technical, economic, and safety assessments of projects.

PLO 8 - Use databases, mathematical tools, and software applications for data processing and computer modeling of biological and biotechnical systems.

PLO 9 - Communicate effectively with healthcare professionals in the national language and in a foreign language (English or another official EU language), understand their requirements for biomedical products and services, and consider historical context and the principles of a healthy lifestyle.

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of study according to the relevant educational program)

The study of the discipline is preceded by the mastery of the courses "Cell Biology", "Human and Animal Physiology", "Biochemistry", "Genetics" and "Industrial Ecology".

The educational discipline belongs to the cycle of elective educational disciplines, therefore its normative (mandatory) connection with other disciplines is not provided for in the structural and logical scheme of education.

3. Content of the academic discipline

Lecture topics:

№ з/п	**Lecture Topic and List of Key Issues** ***(didactic tools, literature references, and independent study tasks)***
1	**Section 1. Individual Development of Organisms** **Topic 1.** ***Historical Background of Embryology Development. Modern Research Methods in Developmental Biology*** (2 hours) Concepts of ancient physicians regarding embryonic development in humans and animals. Embryological studies and theories during the Renaissance. Fundamental principles of the germ layer theory and cell theory. The concept of ontogenesis as individual organismal development. Comparative and evolutionary approaches in embryological research. **Literature**: [1, 2, 5, 6, 7] **Independent Study Tasks (Self-Study):** 1. Molecular-genetic and molecular-biological methods for detecting gene expression. 2. Methods for labeling embryonic tissues. **Literature: [2, 3, 4, 7]**
2	*Topic 2.* ***Periods of the Animal Life Cycle*** (2 hours) Subject matter of animal embryology. Modes and forms of reproduction. Sexual reproduction. Main stages of embryogenesis: initial, embryonic, and fetal stages. **Literature**: [2, 3, 4, 7] **Independent Study Tasks (Self-Study):** 1. Comparative characteristics of sexual and asexual reproduction. 2. Changes during the juvenile period associated with sexual maturation. Literature: [2, 3, 4, 7]

№ з/п	**Lecture Topic and List of Key Issues *(didactic tools, literature references, and independent study tasks)***
3	**Topic 3*. Influence of Environmental Factors on Ontogenesis*** (2 hours) Svetlov's theory of critical periods. Sensitivity of organisms to external influences during critical stages of development. Critical periods of human biosocial development: early childhood, prepubertal, and pubertal stages. Key events, hormonal shifts, and somatic transformations during these periods. Literature: [1, 2, 16, 17] Independent Study Tasks (Self-Study): 1. Determining environmental factors and their influence on phenotypic traits. 2. Classification of teratogens. Literature: [1, 2, 16, 17]
4	***Topic 4. Structure and Development of Gametes. Sexual Cycles. Fertilization and Its*** Biological Significance. Biological Age (2 hours) Characteristics of germ and somatic cells. Definition of oogenesis and its stages. Secretion of sex hormones during ontogenesis and across different seasons. Effects of sex hormones on the central nervous system, behavior, and other organs and tissues in animals. Hormonal regulation of the sexual cycle in mammals. Fertilization and its biological significance; gamete interaction and chemotactic factors. Literature: [1, 2, 12, 13, 17] Independent Study Tasks (Self-Study): 1. Structure and properties of the ovum. 2. Morphology and physiology of sperm cells. 3. Types of egg nutrition. 4. Monocyclic and polycyclic animal species. 5. Acrosomal reaction of spermatozoa and its role in gamete fusion. Literature: [1, 2, 12, 13, 17]
5	***Topic 5. General Characteristics of the Cleavage Process (2 hours)*** Introduction to this field of reproductive and developmental biology. Specific features of cell division during cleavage. Types of cleavage and their characteristics. Structure of the blastula in animals with different cleavage patterns. Literature: [1, 2, 3, 4, 5, 6, 7] Independent Study Tasks (Self-Study): 1. Characteristics of cleavage and blastocyst formation in mammals. Literature: [1, 2, 3, 4, 5, 6, 7]

№ з/п	Lecture Topic and List of Key Issues *(didactic tools, literature references, and independent study tasks)*
6	***Topic 6. Gastrulation. Germ Layers (2 hours)*** Gastrulation as a stage of ontogenesis involving the formation of a multilayered embryo. Formation f the ectoderm, endoderm, and mesoderm. Literature: [1, 2, 8, 15, 17]. **Independent study tasks:** 1. Structural features of the gastrula in chordates. 2. Methods of mesoderm **Literature:** [1, 2, 8, 15, 17].
7	***Topic 7. Neurulation. Determination and Embryonic Induction (2 hours)*** Embryonic induction and the role of inductive interactions in embryogenesis. Characteristics of the neurulation stage. Primary embryonic induction. Concept of the inducer and the responding tissue. Literature [1, 2, 8, 15, 17]. Independent study tasks: 1. Mechanisms and stages of determination. 2. Methods of neural tube formation. Literature [1, 2, 8, 15, 17].
8	***Topic 8. Basic processes of embryogenesis (2 hours)*** The main cytophysiological processes that directly determine the formation of shape during embryogenesis. Diffusion-reaction model of differentiation. The most important cytophysiological processes that are involved in gene expression References [1, 2, 8, 15, 17]. Tasks for the CRC: 1. Cytophysiological mechanism of amoeboid cell movement 2. The role of fibronectins in morphogenesis References [1, 2, 8, 15, 17]
9	***Topic 9. Cloning in the biology of individual development (2 hours)*** Determination of the main cytophysiological processes that directly determine the formation of forms during embryogenesis. Paracrine factors and transcription factors, their role in the regulation of morphogenesis. Literature [1, 2, 5, 7]. Tasks for the CRC: 1. Cytophysiological mechanism of amoeboid cell movement. 2. Diffusion-reaction model of differentiation Literature [1, 2, 5, 7].

№ з/п	Lecture Topic and List of Key Issues *(didactic tools, literature references, and independent study tasks)*
10	***Topic 10 Mechanisms of Developmental Biology in Evolutionary Change (2 hours)*** Developmental structure in the genome, Modularity: divergence through dissociation. Recruitment. Molecular economy: gene duplication and divergence. Mechanisms of evolutionary change. Evolution and symbiosis of development. Literature [2, 3, 5, 6, 7]. Tasks for the SRS: 1. Constraints on evolution imposed by development. 2. Ecological evolutionary biology of development Literature [2, 3, 5, 6, 7].
11	**Section 2. Fundamentals of Evolutionary Theory** ***Topic 1. Introduction to the theory of evolution. Anti-evolutionary views. Variety of evolutionary theories (2 hours)*** History of the struggle between evolutionary and anti-evolutionary views. Anti-evolutionary views: their content and analysis (creationism, teleology, transformism). Variety and classification of evolutionary theories (exogenous and endogenous evolutionary theories, genetic theories of evolution, theories of natural selection, deterministic and stochastic theories, synthetic theories of evolution). Literature [1, 16, 17]. Tasks for the SRS: 1. Creationism: the essence and representatives of the doctrine 2. Teleology: the essence and representatives of the doctrine 3. Transformism: the essence and representatives of the doctrine 1. 4. The theory of evolution as the theoretical foundation of modern biology. Literature [1, 16, 17].

№ з/п	Lecture Topic and List of Key Issues *(didactic tools, literature references, and independent study tasks)*
12	***Topic 2. Pre-Darwinian period in biology Natural scientific prerequisites for the emergence of Darwinism (Basic provisions of the evolutionary theory of Charles Darwin. (2 hours)*** Descriptive period in biology. The problem of spontaneous generation of life and the possibility of unlimited variability of species. Development of binary nomenclature. Works of K. Baugin. Development of criteria for species. Works of J. Ray. Works of C. Linnaeus. Their significance for the creation of an evolutionary theory. Evolutionary theory of J. B. Lamarck. Formation of basic evolutionary concepts. Logical structure of Darwinism. Significance of Charles Darwin's theory. Forms of struggle for existence. Forms of variability according to Charles Darwin. Adaptation and their classification. Formation and crisis of classical Darwinism. Creation of a synthetic theory of evolution (STE). Basic provisions (postulates) of STE. Literature [1, 16, 17]. Tasks on SRS: 1. Ancient and medieval views on living nature. 2. Features of medieval views on nature. 3. Public perception of the evolutionary theory of J.B. Lamarck. 4. The relative nature of adaptations. 5. The life and work of Charles Darwin. 6. Public perception of Charles Darwin's evolutionary theory in different socio-political eras and in different countries of the world. Literature [1, 12, 13, 17].
13	***Topic 3. Microevolution. Elementary evolutionary factors / Natural selection (2 hours)*** General characteristics of elementary evolutionary factors. Mutation process. Recombination. Gene drift. Baldwin effect. Concept of natural selection. Concept of genetic neutralism and "non-Darwinian" theories of evolution. Basic forms of natural selection. Higher forms of natural selection. Literature [1, 2, 3, 4, 12, 13, 17]. Tasks for the SRS: 1. Genetic heterogeneity and uniqueness of natural populations 2. Modern problems of the theory of selection. Literature [1, 12, 13, 17].

№ з/п	Lecture Topic and List of Key Issues *(didactic tools, literature references, and independent study tasks)*
14	***Topic 4. Biological species. Speciation (1 hour)*** Biological species. The concept of species in uniparental organisms. The concept of species in fossil forms (paleontological species). The concept of biological species. Speciation. Incomplete speciation and hybridogenesis. Literature [1, 12, 13, 17]. Tasks for the SRS: 1. Features of the formation of modern species in different regions of the Earth. 2. Problems of species and speciation in modern biology. Literature [1, 12, 13, 17].
15	***Topic 5. Basic laws and mechanisms of macroevolution (1 hour)*** Evidence of the evolution of the organic world. Macroevolution. The relationship between macroevolution and microevolution. General laws of evolution. Cladogenesis. Divergent evolution. Anagenesis and stasigenesis. Convergence. Parallelism. Synthesogenesis. Literature [1, 12, 13, 17]. Tasks for the SRS: 1. Convergence, parallelism, synthesis in modern scientific literature Literature [1, 12, 13, 17] Test.

Topics of practical classes:

№ з/п	Title of a practical class topic and list of main questions (list of didactic material, references to literature and tasks on the SRS)
1	**Research methods in developmental biology** *General characteristics of embryological preparations. Methods of embryological analysis are considered* *Literature [2, 3, 4, 5, 6, 7].* *SRS: Homework in a workbook on this topic*.
2	**Evolution of ontogenesis, organs and functions.** *Morpho-functional characteristics of the stages of human ontogenesis.* *Literature: [2, 3, 4, 5, 6, 7]* *STS: Homework in a workbook on this topic*.
3	**The structure of male and female reproductive glands.** *General characteristics of germ cells. Morphofunctional characteristics of female gametes. Morphofunctional characteristics of male gametes* *Recommended literature: [2, 3, 4, 5, 6, 7]* *SRS: Doing homework in a workbook on this topic*.
	Origin of primary germ cells

4	*General characteristics of meiosis. Oogenesis. Spermatogenesis.* *Recommended readings: [2, 3, 4, 5, 6, 7]* *SRS: Homework in a workbook on this topic.*
5	**Fertilization.** *General characteristics of the fertilization process. Distant interaction of gametes. Reactions of activation and metabolism of the egg. Processes that occur after the penetration of the sperm into the egg. Ovoplasmic segregation* *Recommended literature: [2, 3, 4, 5, 6, 7]* *SRS: Homework in the workbook on this topic*
6	**Parthenogenesis and androgenesis** *Natural parthenogenesis and its distribution in nature. Artificial parthenogenesis, its theoretical and practical significance* *Recommended literature: [2, 3, 4, 5, 6, 7]* *SRS: Homework in a workbook on this topic.*
7-8	**Definition and biological significance of cleavage** *Features of cell cycles during cleavage. Spatial organization of cleavage, Complete uniform cleavage, Complete uneven cleavage. Ovoplasmic segregation during cleavage. The role of contact interactions between blastomeres in the processes of their differentiation Recommended literature: [2, 3, 4, 5, 6, 7]* *SRS: Completing homework in a workbook on this topic.*
9	**General characteristics of the blastulation process** *General patterns of blastocoel formation. Classification of blastulae.* *Recommended readings: [2, 3, 4, 5, 6, 7]* *STS: Homework assignments in a workbook on this topic.*
10	**General characteristics of gastrulation** *Germ layers and general principles of their formation. Methods of gastrulation. Concepts of competence and determination. Types of determination. The importance of the extracellular matrix in supporting gastrulation movements.* *Recommended literature: [2, 3, 4, 5, 6, 7]* *SRS: Homework in a workbook on this topic.*
11	**Axial organ formation** *General characteristics of the processes underlying the formation of axial organs in chordates. The concept of primary embryonic induction. Mechanisms of neural tube formation. General characteristics of the neural tube differentiation process. Transformation of the mesoderm during neurulation.* *Recommended literature: [2, 3, 4, 5, 6, 7]* *SRS: Homework assignments in a workbook on this topic.*
12-13	**Organogenesis** *General characteristics of organogenesis. Embryonic induction and its prerequisites. Processes underlying organogenesis. Differential gene activity and its significance in organogenesis processes. Regulation and regeneration in organogenesis. Features of growth in organogenesis.*

	Recommended literature: [2, 3, 4, 5, 6, 7] *SRS: Homework assignments in a workbook on this topic*

4. Educational materials and resources

Basic literature:

1. Основи еволюційної теорії: навчальний посібник з дисципліни «Біологія розвитку та основи еволюційної теорії» для студентів спеціальності 162 – Біотехнології та біоінженерія спеціалізації «Промислова біотехнологія» / Уклад.: О.Ю. Галкін, Л.О. Тітова. – К.: КПІ імені Ігоря Сікорського, 2018. – 121 с.
2. Загальна цитологія: підручник. / М.Е. Дзержинський, Н.В. Скрипник, А.С. Пустовалов, Г.В. Островська, І.М. Варенюк, О.К. Вороніна, Л.М. Пазюк, С.М. Гарматіна; упорядкування Н.В.Скрипник. – Київ: ВПЦ «Київський університет», 2020.– 640 с.
3. Гістологія. Цитологія. Ембріологія / за ред. професор О.Д. Луцика та професора Ю.Б. Чайковського. — Вінниця: Нова Книга, 2018. — 592 с.
4. *Новак В.П., Бевз О.С., Мельниченко А.П.Цитологія, гістологія, ембріологія : підручник / за заг. ред. В.П. Новака. – 3-тє вид., змінене і доп. – Львів : Магнолія 2021. – 436 с.*
5. **Варенюк І.М., Дзержинський М.Е. Методи цито-гістологічної діагностики: навчальний посібник.– Київ: Інтерсервіс, 2019.– 256 с.**
6. Ященко АМ, Єлісєєва ОП, Білий РО, Панкевич ЛВ, Наконечна ОВ, Дудок ВВ, Смолькова ОВ, Джура ОР, Челпанова ІВ, Амбарова НО, Дудок ОВ, Луцик ММ, Согомонян ЄА, Струс ХІ. Загальна гістологія для студентів медичного факультету. Навчальний посібник для практичних занять та самостійної позааудиторної роботи з гістології, цитології та ембріології / Ред. Луцик О.Д. Львів, ЛНМУ. 2017: 94с.
7. «Гістологія, цитологія, ембріологія» для студентів стоматологічних факультетів ЗВМО України / О.Д.Луцик, Ю.Б.Чайковський, Р.Г.Білий ; за ред.: О.Д.Луцика, Ю.Б.Чайковського. – Вінниця : Нова Книга, 2020. – 496 с

Additional literature:

1. Дзержинський М. Е., Скрипник Н. В., Вороніна О. К., Пазюк Л. М. «Біологія індивідуального розвитку. Частина І. Практикум» : навч. посіб. Видавничо-поліграфічний центр «Київський університет», 2014. – 271 с
2. Дзержинський М.Е., Скрипник Н.В., Островська Г.В., Гарматіна С.М., Пазюк Л.М., Бузинська Н.О., Варенюк І.М., Пустовалов А.С., Вороніна О.К.. Загальна цитологія та гістологія.– Київ: ВПЦ "Київський університет", 2010.– 575 с.
3. Дзержинський М.Е., Вороніна О.К.,Скрипник Н.В., Гарматіна С.М., Пазюк Л.М. Загальна цитологія. Практикум: навчальний посібник. - К.: Видавничо-поліграфічний центр
   «Київський університет», 2011. – 126 с.
4. Під ред. Е.Ф.Баринова, Ю.Б.Чайковського. Цитологія і загальна ембріологія.

Навчальний посібник. Київ, ВСВ «Медицина», 2010.- 216 с.

5. Гістологія, цитологія та ембріологія. Атлас : навч. посіб. / О.Ю. Степаненко, О.В. Мірошніченко, Л.О. Зайченко та ін. — 2-е вид. — К. : ВСВ «Медицина», 2020. — 152 с.
6. Черняк Я. І., Д. В. Максимів Д. В., Матійців Н. П. та ін. Біологія індивідуального розвитку тварин: навч. посібник: [для студентів вищих навчальних закладів] — Львів: ЛНУ імені Івана Франка, 2013. — 168 с.
7. Новак В.П, Цитологія, гістологія, ембріологія: Підручник (2-е вид., змін. і доп.) / За заг.ред. В.П. Новака; [уклали: Новак В.П, Бичков Ю.П., Пилипенко М.Ю.] - К.: Дакор, 2008.- 512 с.
8. Ігнатенко І.А. Біологія індивідуального розвитку: навч. посіб. для студентів денної та заочної форми навчання спеціальності 6.070402 – Біологія / укладач: І.А. Ігнатенко – Черкаси; ПП. «Дар-Гранд», 2011, - 123 с.
9. Барціховський В.В. Медична біологія: підручник / В.В. Барціховський, П. Я Шерстюк. – 2-е вид. випр. – К.: ВСВ «Медицина», 2012. – 312 с.
10. Медична біологія / За ред. В.П. Пішака, Ю.І.Бажори. Підручник. – Вінниця: НОВА КНИГА, 2004. – 656 с.: іл.
11. Рожков І.М.. Основи цитології, ембріології та гістології: Навчальний посібник / Рожков І.М., Гордієнко В.М., Олейник В.П./ За ред. І.М. Рожкова. – Миколаїв: Вид-во МДУ ім. О.Сухомлинського, 2007. - 183 с.
12. Wassarman P. M.. Towards the molecular basis of sperm and egg interaction during mammalian fertilization / Wassarman P. M., Litscher E. S. // Cells Tissues Organs. 2001. - Vol. 168. - P. 36–45.
13. Gilbert S. F. Developmental Biology / S. F. Gilbert. 9th ed. Sunderland, 2009.- P. 360-364.
14. Elle E. Reproductive assurance varies with flower size in Collinsia parviflora (Scrophulariaceae) / Elle E., Carney R. //Am. J. Bot, 2003. - Vol. 90. – P. 888-896
15. Harrison M. M.. Zelda binding in the early Drosophila melanogaster embryo marks regions subsequently activated at the maternalto-zygotic transition. / Harrison M. M., Li X. Y., Kaplan T., Botchan M. R., Eisen M. B. // PLoS Genet. 2011. - Vol. 7, N 10. -P 123-134.
16. Satzinger H. Theodor and Marcella Boveri: chromosomes and cytoplasm in heredity and development / Satzinger H. // Nature Rev. Gen. 2008. - Vol. 9. - P. 231–238..
17. Wray G. A. The evolution of echinoderm development is driven by several distinc factors. The evolution of developmental mechanisms / Wray G. A., Bely A. E. // Dev. Suppl. 1994.- P. 97–106.

Information resources

1. Vernadsky National Library of Ukraine: www.nbuv.gov.ua.
2. Online collection of published scientific research ScienceDirect: www.sciencedirect.com.

3. National Center for Biotechnology Information of the National Library of Medicine of the United States: www.ncbi.nlm.nih.gov.
4. National Academy of Sciences of Ukraine: www.nas.gov.ua.
5. National Academy of Medical Sciences of Ukraine: www.amnu.gov.ua. World Health Organization: www.who.int

Educational content

5. Methodology for mastering the academic discipline (educational component)

Lecture classes

Lectures are held according to the classic scheme: in a visual form, the lecturer presents the relevant topic. During the lecture and after it, candidates have the opportunity to ask questions. A discussion between the lecturer and candidates can be held on individual issues of the lecture course - or to focus on important, fundamental and problematic points. Candidates can take notes during the lectures, and the presentation and/or lecture notes or its fragments are presented with the possibility of downloading on the distance learning platform "Sikorsky".

Practical classes

Practical classes are aimed at acquiring deeper knowledge and skills on topics covered in the lecture course and independently mastered by applicants. The algorithm for conducting a practical class provides for the following: the teacher presents basic (strategic) theses within the framework of the relevant topic, applicants make mini-reports with pre-formed problem questions within the framework of the relevant topic, a discussion takes place between the speaker, other applicants and the teacher, which aims to clarify all the fundamental and example aspects of the relevant technologies of regenerative medicine. Applicants' reports involve the preparation of a corresponding analytical note in the form of a small review of literature in Ukrainian, as well as a visual presentation, which allows you to deepen your skills in written and oral scientific Ukrainian. If necessary, during practical classes, regulatory documents, methodological recommendations, etc., are studied (familiarized), as well as solving situational problems. At the last practical session, applicants complete a modular test (MCT) in the form of a test. Material that is useful for preparing for practical sessions is provided with the ability to download it on the distance learning platform "Sikorsky". Lectures and practical sessions are held according to the schedule of classes http://rozklad.kpi.ua/ according to the following scheme: first, lectures are held, and after their completion, practical sessions. Detailed information is

provided to applicants through appropriate communication channels, in particular through the platforms "Sikorsky" and "Campus".

6. Independent work of the applicant

The total amount of independent work within the discipline is 64 hours, including: preparation for practical classes - 15 hours;
preparation for modular control work (MCW) - 5 hours; independent study of topics - 34 hours.
preparation for the test (10 hours)

Policy and control

7. Academic discipline policy (educational component)

Violation of task deadlines and incentive points

Applicants may be awarded incentive points. The total amount of incentive points cannot exceed 10 points.

Incentive points are awarded for the following activities:

- creating infographics or other means of graphical interpretation of information for one of the course topics (5 points);
- participation in international or all-Ukrainian scientific conferences, congresses, etc. (on the subject of the academic discipline) (subject to publication of abstracts of reports) (5 points);
- preparation of a manuscript of a review or experimental article or participation in competitions (subject to taking a prize place) on the subject of the academic discipline (10 points).

Attending classes

Penalty points for absence from classes are not given. However, applicants are recommended to attend classes, as they teach theoretical material and develop practical skills necessary for the thorough formation of relevant competencies.

The assessment system is focused on obtaining points for student activity, as well as completing tasks that can develop practical skills and abilities.

Missed assessment controls

Assessment controls, the implementation of which is provided for in the lesson, are carried out on a predetermined day, which is announced to applicants in the first week of the

educational process. Implementation of such assessment controls on another day is allowed under serious and/or force majeure circumstances.

In the event of the applicant's absence from a practical lesson, where his/her speech with a message is expected, such speech is either transferred to another practical lesson, or replaced by the preparation of an analytical note on the relevant topic of 5-10 pages (in the case of special force majeure circumstances).

The result of the modular test for an applicant who did not appear for the test is zero. In this case, the applicant has the opportunity to complete the modular test at another time in agreement with the teacher. Postponement of the test date is possible only for good reasons (force majeure circumstances).
Re-testing within the framework of the modular test is not provided.

Ensuring objectivity in assessing applicants

The objectivity of the assessment of applicants at all stages of mastering the discipline is ensured through the following mechanisms. First, the use of test forms for assessing knowledge. Second, detailed recommendations on the rating system for assessing learning outcomes (Section 8 of the Syllabus). Third, the use by applicants and teachers of all possible communication tools that ensure the preservation of the history of communications (e-mail, social networks, messengers , etc.). Fourth, in case of disagreement with the assessment results, another teacher who has the appropriate professional competence and is appointed by the department for the current academic year may be involved in checking the written works of applicants. In the absence of a coordinated opinion of the teachers on the assessment of the applicant's work, the issue is brought to a meeting of the department, and the issue is resolved in accordance with the "Regulations on Appeals at Igor Sikorsky Kyiv Polytechnic Institute" http://osvita.kpi.ua/node/182 .

Procedure for appealing the results of assessment control measures

After receiving comments from the teacher with arguments regarding the assessment, the applicant has the right to individually ask all questions of interest regarding the results of the assessment control measures. If the applicant does not agree with the assessment, he must also provide arguments regarding his position and contact the dean of the faculty for further resolution of the issue (for details, see the "Regulations on Appeals at Igor Sikorsky Kyiv Polytechnic Institute" http://osvita.kpi.ua/node/182).

Academic integrity

When using copyrighted content, analytical research results, and/or other information, applicants must cite the source.

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (https://kpi.ua/code). In the event of a need to check academic texts prepared for applicants for the presence of text borrowings, the applicant may contact the teacher or the responsible person of the department for checking academic texts.

Norms of ethical behavior

The norms of ethical behavior of applicants and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (https://kpi.ua/code ***).***

Distance learning

Online courses are provided in case of force majeure circumstances (in particular, quarantine measures) and for inclusive education of applicants with special needs.

Inclusive learning

The academic discipline is designed for students with special educational needs, but it should be taken into account that it places a heavy load on the visual apparatus. Depending on the special needs of students, distance learning may be used***.***

8. Types of control and rating system for assessing learning outcomes (RSO)

Current control. Work in practical classes involves short reports by the applicant on a predetermined question (3 reports for each applicant). Each report is evaluated at 20 points: full disclosure of the question – 20 points, the presence of minor omissions – 15-19 points, the presence of minor errors – 10-14 points, the presence of significant errors – 5-9 points. Unsatisfactory answer – 0 points

In the process of mastering the discipline “DEVELOPMENTAL BIOLOGY AND FUNDAMENTALS OF EVOLUTIONARY THEORY”, students perform modular control work. The work is carried out in 2 stages – separately by blocks of ontogenesis and the foundations of evolutionary doctrine. The purpose of the control work is to form:

1) the ability to formulate the main provisions of the synthetic theory of evolution, to reveal the mechanisms of macro- and microevolution, to reveal the essence of ontogenesis and phylogenesis;

2) experience in finding mechanisms of evolutionary processes on examples of adaptation of modern representatives of flora and fauna.

Modular test work (MKR) is carried out in the form of a test, which is estimated at 40 points. The number of questions in the test work is 20. The maximum number of points for answering one question is 2 points.

Calendar control: is carried out twice a semester as a monitoring of the current status of the implementation of the syllabus requirements. The first checkpoint assumes the presence of one message from the applicant at a practical lesson, the second - at least two messages.

The maximum semester rating of the applicant: 60 points (3 messages at practical lessons) + 40 points (MKR) = 100 points.

Semester control: credit. Conditions for admission to semester control: completion of three messages at practical lessons and completion of MKR (with a total rating of at least 60 points). In the case of a semester rating of 60 points and above, the applicant can receive a credit automatically. In case of disagreement or a rating of less than 60 points, a credit is taken in the form of testing.

Table of correspondence of rating scores to university scale grades

Number of points	***Rating***
100-95	Perfectly
94-85	Very good
84-75	Good
74-65	Satisfactorily
64-60	Enough
<60	Unsatisfactorily
Admission conditions not met	Not allowed

9. Additional information on the discipline (educational component)

The questions submitted for semester control correspond to the topics of lectures and practical classes.

Recognition of learning outcomes acquired in non-formal/ informal education is carried out in accordance with the "Temporary Regulation on the Procedure for Recognition of Learning Outcomes Acquired by Students of Igor Sikorsky Kyiv Polytechnic Institute in Non-formal/ Informal Education" (https://osvita.kpi.ua/node/119).

The working program of the academic discipline (syllabus):

Compiled by Poedynok N. L.;

Approved by the Department of Biomedical Engineering (protocol № 16 of June 21, 2024)

Approved by the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 9 of June 26, 2024)