**Federal State Autonomous Educational Institution of Higher Education "Moscow Institute of Physics and Technology (National Research University)"**

**APPROVED**
**Head of the Phystech School of Biological and Medical Physics**
**D.V. Kuzmin**

**Work program of the course (training module)**

| | |
|---|---|
| **course:** | Evolutionary Biology/Эволюционная биология |
| **major:** | Biotechnology |
| **specialization:** | Biomedical Engineering/Биомедицинская инженерия |
| | Phystech School of Biological and Medical Physics |
| | Center for educational programs in bioinformatics |
| **term:** | 4 |
| **qualification:** | Bachelor |

Semester, form of interim assessment: 8 (spring) - Exam

Academic hours: 30 AH in total, including:
- lectures: 30 AH.
- seminars: 0 AH.
- laboratory practical: 0 AH.

Independent work: 30 AH.

Exam preparation: 30 AH.

In total: 90 AH, credits in total: 2

Author of the program: V.A. Skobeeva, candidate of biological sciences, заместитель директора по учебно-методической работе

The program was discussed at the Center for educational programs in bioinformatics 05.07.2023

**Annotation**

One term course of lectures gives short survey of modern evolution theory. Different concepts of modern biodiversity origin, basics of modern evolution theory and some applications of these concepts are covered by this course.

## 1. Study objective

**Purpose of the course**

- to develop familiarity with modern concepts of evolutionary development.
- to give an idea of phylogenetic relations, methods of building phylogenies and application of evolutionary relations in modern biology.

**Tasks of the course**

- give students the skills of using modern evolutionary concepts in their research.
- give students the skills of using evolutionary methodology in their experimental design and analysis.

## 2. List of the planned results of the course (training module), correlated with the planned results of the mastering the educational program

Mastering the discipline is aimed at the formation of the following competencies:

| Code and the name of the competence | Competency indicators |
|---|---|
| UC-1 Search and identify, critically assess, and synthesize information, apply a systematic approach to problem-solving | UC-1.1 Analyze problems, highlight the stages of their solution, plan the actions required to solve them |
| | UC-1.2 Find, critically assess, and select information required for the task in hand |
| | UC-1.3 Consider various options for solving a problem, assess the advantages and disadvantages of each option |
| | UC-1.4 Make competent judgments and estimates supported by logic and reasoning |
| | UC-1.5 Identify and evaluate practical consequences of possible solutions to a problem |

## 3. List of the planned results of the course (training module)

As a result of studying the course the student should:

know:

- basic concepts of modern evolutive theory.

be able to:

- analyze data of structure and function of organisms from evolutionary scope.

master:

- the methodology of analysis of evolutionary history of given organisms and sequences.

## 4. Content of the course (training module), structured by topics (sections), indicating the number of allocated academic hours and types of training sessions

4.1. The sections of the course (training module) and the complexity of the types of training sessions

| № | Topic (section) of the course | Types of training sessions, including independent work | | | |
|---|---|---|---|---|---|
| | | Lectures | Seminars | Laboratory practical | Independent work |
| 1 | The problem of biodiversity origin | 2 | | | 2 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | The struggle for life and natural selection. | 3 | | | 2 |
| 3 | Types of natural selection | 3 | | | 3 |
| 4 | Ontogenesis | 2 | | | 3 |
| 5 | Signal pathways and pleiotropic genes | 3 | | | 2 |
| 6 | Evolutionary novelties. Polymorphism | 3 | | | 3 |
| 7 | The origin of life. Life before cells. Hypothesis of multicellularity origin | 2 | | | 2 |
| 8 | Cambrian period. Paleosoic era. Mesosoic era. | 2 | | | 2 |
| 9 | The lineage of modern human | 2 | | | 3 |
| 10 | The pithecanthropus erectus or Java man. Homo erectus | 3 | | | 2 |
| 11 | The origin of modern type human | 3 | | | 3 |
| 12 | Modern societies and their specific diseases | 2 | | | 3 |
| AH in total | | 30 | | | 30 |
| Exam preparation | | 30 AH. | | | |
| Total complexity | | 90 AH., credits in total 2 | | | |

4.2. Content of the course (training module), structured by topics (sections)

Semester: 8 (Spring)

1. The problem of biodiversity origin

The problem of the biodiversity origin. History of study and conceptualization. Variability according to Darwin and modern views. Definite and indefinite variability. Mutations, modification variability, combinatorial variability/ Frequency of de novo mutations.

2. The struggle for life and natural selection.

Absolute and relative fitness. Allelic dynamic in selection against dominant allele, against recessive allele. Heterozygote advantage, homozygote advantage. Mathematic description of natural selection. Genetic drift and natural selection.

3. Types of natural selection

Stabilizing selection in organisms and sequences. Driving selection in organisms and sequences. Diversifying selection

4. Ontogenesis

Decomposition of phenotypic variability. Variability of quantitative characters. Way from genotype to phenotype in ontogenesis. Genes with big and small effects

5. Signal pathways and pleiotropic genes

Signal pathways and pleiotropic genes. Creodes and adaptive landscape

6. Evolutionary novelties. Polymorphism

Evolutionary novelties – how new traits originate. Polymorphism in populations and evolutionary novelties. Altruism in nature.

7. The origin of life. Life before cells. Hypothesis of multicellularity origin

The origin of life. World before living cells appeared. Prokariotic cells, the origin of aerobic energetics. Eukariotic cell – the symbiogenesis theory. World before multicellularity. Hypothesis of multicellularity origin

8. Cambrian period. Paleosoic era. Mesosoic era.

Ediacaran period. Cambrian period, Cambrian explosion. The origin of modern types of animals. Paleozoic era. Plants and animals landing. Mesosoic era. Rise and fall of dinosaurs. Impact and biotic hypotheses.
Cenozoic era. Origin of modern mammalian orders and families, birds and flowering plants. Rise of insects.

9. The lineage of modern human

Origin of the modern human lineage. Australopithecs. Environmental conditions of the lineage of Homo habilis origin. The origin of bipedalism

10. The pithecanthropus erectus or Java man. Homo erectus

Homo erectus. First migration from Africa. The culture of Homo erectus, mastering of fire

11. The origin of modern type human

The origin of modern type human. Neanderthal man and his culture. Genes, associated with human speech.
Cro magnon man. The second migration from Africa, distribution of cro magnon men. The formation of local populations, neolitic revolution. Possible social structures of first agricultural settlements.

12. Modern societies and their specific diseases

Modern societies and their specific diseases. The second demographic transition and its role in the creation of the modern genetic structure of human populations

**5. Description of the material and technical facilities that are necessary for the implementation of the educational process of the course (training module)**

Class room, multimedia projector and screen, notebook.

**6. List of the main and additional literature, that is necessary for the course (training module) mastering**

Main literature

Литература предоставляется базовой кафедрой.
D. Futyuma, M. Kirckpatrick. Evolution. - Sunderland, Massachusetts U.S.A.: Sinauer Associates, 2017. - 600 p.
Д. Б. Рисс, Л. А. Урри и др. Биология Campbell: в 3 томах. Том 1. Химия жизни. Клетка. Генетика. - Диалектика, 2021. - 672 с.

Additional literature

Литература предоставляется базовой кафедрой.
Дополнительная литература
Рекомендованная литература для самостоятельного изучения:
А. В. Марков. Эволюция человека. Т. 1. Обезьяны, кости, гены. - М.: Астрель: Corpus, 2011. - 510 с.
А. В. Марков, Е. Б. Наймарк. Эволюция. Классические идеи в свете новых открытий. - М.: АСТ, Corpus, 2014. - 656 с.
А. С. Северцов. Теория эволюции. - М.: Гуманитар. изд. цетр ВЛАДОС, 2005. - 380 с.

**7. List of web resources that are necessary for the course (training module) mastering**

Not used

**8. List of information technologies used for implementation of the educational process, including a list of software and information reference systems (if necessary)**

MS Office/

**9. Guidelines for students to master the course**

Successful mastering of the course implies attending lectures/

**SUPPLEMENT**

**Assessment funds for course (training module)**

| | |
|---|---|
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| **term:** | 4 |
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Semester, form of interim assessment: 8 (spring) - Exam

**Author:** V.A. Skobeeva, candidate of biological sciences, заместитель директора по учебно-методической работе

**1. Competencies formed during the process of studying the course**

| Code and the name of the competence | Competency indicators |
|---|---|
| UC-1 Search and identify, critically assess, and synthesize information, apply a systematic approach to problem-solving | UC-1.1 Analyze problems, highlight the stages of their solution, plan the actions required to solve them |
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| | UC-1.4 Make competent judgments and estimates supported by logic and reasoning |
| | UC-1.5 Identify and evaluate practical consequences of possible solutions to a problem |

**2. Competency assessment indicators**

As a result of studying the course the student should:

**know:**

- basic concepts of modern evolutive theory.

**be able to:**

- analyze data of structure and function of organisms from evolutionary scope.

**master:**

- the methodology of analysis of evolutionary history of given organisms and sequences.

**3. List of typical control tasks used to evaluate knowledge and skills**

1.Relationship between drift and selection as a function of population size. Neutral polymorphism - definition, examples.

2.Examples of diseases that persist in a population due to the predominance of heterozygotes. Polymorphism affecting fitness - reasons for maintenance.

3.Founder and bottleneck effects - different consequences.

4.Influence of crossbreeding systems on the gene pool of a population. Crossing systems.

5.Examples of the role of interaction between genotype and environment in the pathogenesis of socially significant diseases.

**4. Evaluation criteria**

1.Creationism as a hypothesis about the origin of biodiversity.

2.Conditions for the stable Hardy-Weinberg equilibrium.

3.The difference between positive assortative and selective mating system.

4.Transformism as a hypothesis about the origin of biodiversity.

5.Decomposition of the phenotypic dispersion of a trait.

6.Effect of negative assortative crossing on allele and genotype frequencies.

7.Neutral polymorphism - definition, examples.

8.Relationship between drift and selection as a function of population size

9.Polymorphism affecting fitness - reasons for maintenance. Examples of diseases that persist in the population due to the advantage of heterozygotes.

10.The Founder and Bottleneck Effects - Various Consequences of the mating system.

11.The influence of mating systems on the gene pool of a population.

12.Decomposition of phenotypic variance. Examples of the role of interaction between genotype and environment in the pathogenesis of socially significant diseases.

13.The role of natural selection in the formation of variability in polygenic traits. Give examples of the influence of one gene on variability by polygenic trait.

14.Lifestyle diseases - give examples, put forward hypotheses about the reasons for their prevalence at the present time

15.Methods for assessing the role of heredity and environment in the formation of a quantitative trait. Causes of selection inefficiency in pure lines.

Ticket number 1

1.The influence of mating systems on the gene pool of a population.

2.Decomposition of phenotypic variance. Examples of the role of interaction between genotype and environment in the pathogenesis of socially significant diseases.

Excellent grade (10 points) - is given to a student who has shown comprehensive, systematized, in-depth knowledge of the curriculum of the discipline, showing interest in this subject area, demonstrating the ability to confidently and creatively apply them in practice when solving specific problems, free and correct justification of the decisions made.

Excellent grade (9 points) - is given to a student who has shown comprehensive, systematized, in-depth knowledge of the curriculum of the discipline and the ability to confidently apply them in practice in solving specific problems, free and correct justification of the decisions made.

Excellent grade (8 points) - is given to a student who has shown comprehensive, systematized, in-depth knowledge of the curriculum of the discipline and the ability to confidently apply them in practice in solving specific problems, the correct justification of the decisions made, with some shortcomings.

Grade good (7 points) - is given to a student if he knows the material well, presents it competently and to the point, knows how to apply the acquired knowledge in practice, but does not adequately substantiate the results obtained

Grade good (6 points) - is given to a student if he knows the material well, presents it competently and to the point, knows how to apply the knowledge gained in practice, but allows some inaccuracies in the answer or in solving problems.

The mark is good (5 points) - a student is given if he basically knows the material, correctly and essentially presents it, knows how to apply the knowledge gained in practice, but allows a sufficiently large number of inaccuracies in the answer or in solving problems.

Satisfactory rating (4 points) - is given to a student who has shown a fragmented, disparate nature of knowledge, insufficiently correct formulations of basic concepts, violations of the logical sequence in the presentation of the program material, but at the same time he has mastered the main sections of the curriculum necessary for further education, and can apply the received knowledge by model in a standard situation.

Satisfactory grade (3 points) - is given to a student who has shown a fragmented, disparate nature of knowledge, makes mistakes in the formulation of basic concepts, violates the logical sequence in the presentation of the program material, has poor command of the main sections of the curriculum necessary for further education and hardly applies the knowledge gained even in a standard situation.

Grade unsatisfactory (2 points) - is given to a student who does not know most of the main content of the curriculum of the discipline, makes gross mistakes in the formulation of the basic principles and does not know how to use the knowledge gained in solving typical problems.

Grade unsatisfactory (1 point) - is given to a student who does not know the main content of the curriculum of the discipline, makes gross mistakes in the formulation of the basic concepts of the discipline and generally does not have the skills to solve typical practical problems.

**5. Methodological materials defining the procedures for the assessment of knowledge, skills, abilities and/or experience**

When conducting an oral test, the student is given 40 minutes to prepare. Questioning a student on a ticket should not exceed one astronomical hour.