

**AI-FARABI KAZAKH NATIONAL UNIVERSITY**

**Approved**  
**at the meeting of the scientific and methodological**  
**council of the al-Farabi Kazakh national University**  
**Vice-rector for academic affairs**  
\_\_\_\_\_ **A. K. Hikmetov**  
**protocol No. \_\_ of \_\_\_\_\_, 2020**

**PROGRAM**  
**ENTRANCE EXAM IN THE SPECIALTY**  
**FOR APPLICANTS TO THE PHD PROGRAM IN**  
**SPECIALTY "8D05101-BIOLOGY"**

**ALMATY 2020**

**The program is compiled in accordance with the State educational standard for the specialty "8D05101-BIOLOGY"**

The program was reviewed at the meeting of the department of biophysics and biomedicine  
Protocol No. \_\_ of \_\_\_\_\_, 2020

Head of department \_\_\_\_\_ Tuleukhanov S. T.

Approved at the meeting of the methodological bureau of the faculty of biology and biotechnology  
Protocol No. \_\_ of \_\_\_\_\_, 2020

The Chairman of the methodological bureau \_\_\_\_\_ Yurikova O. Yu.

Approved at the meeting of the academic council of the faculty

Protocol No. \_\_ of \_\_\_\_\_, 2020

Chairman of the Academic council,  
Dean of the faculty \_\_\_\_\_ Zayadan B.K.

Scientific secretary \_\_\_\_\_ Bauenova M.O.

## CONTENT

**1. Goals and objectives of the entrance exam to the doctoral program in the specialty "8D05101-BIOLOGY"** – to identify the level of theoretical readiness of applicants in various fields of biological science, the ability to navigate the dialectical relationship of various levels of organization of life, to have an idea of the main fundamental, classical branches of biology, as well as the methods, tasks and achievements of modern innovative sections of biological science, to assess the extent of their assimilation of program material and formation, developed during training in bachelor's and master's degrees, the necessary skills and abilities to carry out professional activities.

### **2. Requirements for the level of training of persons entering the PhD program**

**The doctoral program** in the specialty "8D05101-Biology" provides for the preparation of doctors of philosophy to work in the field of studying wildlife, the versatile use of biological systems for practical and research purposes, the conservation of biodiversity and the environment, able to carry out qualified scientific research and practical development in this area.

### **3. Prerequisites educational programs**

Cell biology - 3 credits

Environment and conservation of biological diversity - 3 credits

Genomics and proteomics - 3 credits

*Discipline: "Genomics and proteomics"*

### **List of exam topics**

Ideas about the structure and function of genomes and proteomes of organisms of various taxonomic groups and on the application of this knowledge in biology. Modern achievements of molecular genetics and molecular biology are the basis for the development of genomics and proteomics. Components of genomics and proteomics: structural genomics and proteomics, functional genomics and proteomics, evolutionary genomics and proteomics. RNA - and DNA - containing genomes of viruses. Variations in the structural organization and size of virus genomes. The variety of functional sections of RNA and DNA, and the information density of virus genomes and proteomes. The interaction of the genomes of viruses with genomes of prokaryotes and eukaryotes. The size of mitochondrial genomes in representatives of various taxonomic groups. Ploidy and organization of DNA into nucleotides. Structural and functional organization of DNA of mitochondria of mammals and other animals. Genome and proteome of mitochondria of Ascomycetes. Mitochondrial genome and proteome of higher plants. Variation in the size of chloroplast genomes. Ploidy. Changes in ploidy and genome organization in ontogenesis. Structural and functional organization of chloroplast DNA. Repeats and unique sequences. The size of prokaryotic genomes and their structural organization. Structural and functional properties of DNA of prokaryotic genomes. Diversity of genome size in representatives of different taxa of unicellular eukaryotes. Structural organization of their genomes and ploidy. The subject of study of this discipline. Structural and functional organization of genomes and proteomes from viruses to multicellular organisms. The use of knowledge about the genome and the proteome in biological research and manufacturing. Practical skills of using the properties of genomes and proteomes in biology. Components of genomics and proteomics. Advances in the study of organelle genomes and proteomes. Examples of their use in biology. Advances in the study of virus genomes and proteomes and examples of their use in biotechnology.

Present advances in the study of prokaryotic genomes and proteomes and examples of their use in biology. Methods for analyzing genomes and proteomes of various organisms.

### **List of recommended literature**

#### **Main literature**

1. Primrouz S., Tvaymen Z. Genomika. Rol v meditsine [Rol v meditsine]. 2008. 277s.
2. Zagoskina N.V., Nazarenko L.V., Kalashnikova E.A., Zhivukhina E. Biotekhnologiya: teoriya i praktika [Biotechnology: theory and practice]. 2009. 496s.
3. Zhuravleva G.A., Mironova L.N., Inge-Vechtomov S.G. Genom drozhzhey i pervyye shagi v postgenomnyu eru. Molekulyarnaya biologiya [The yeast genome and the first steps in the post-genomic era.]. 2000. tom 34. № 4. s. 560-571.
4. Zelenin A.V., Badayeva E.D., Muravenko O.V. Vvedeniye v genomiku rasteniy. Molekulyarnaya biologiya [Introduction to plant genomics. Molecular biology]. 2001. tom 35. № 3. s. 339-348.
5. Zelenin A.V. Genom rasteniy. Vestnik Rossiyskoy Akademii nauk [Bulletin of the Russian Academy of Sciences]. 2003. tom 73. №9. s.797-806.
6. Kolchanov N.A., Ananko E.A., Kolpakov F.A. i dr. Gennyye seti. Molekulyarnaya biologiya [Gene network. Molecular biology]. 2000. tom 34. № 4. s. 533-544.
7. Lewin B. Genes. 7, Oxford 2000, 999 p..
8. Patrushev L.I. Ekspressiya genov [Gene expression]. M.. 2000. 315 s.
9. Kolchanov N.A., Suslov V.V., Shumnyy V.K. Molekulyarnaya evolyutsiya geneticheskikh sistem. Paleontologicheskii zhurnal [Molecular evolution of genetic systems]. 2003. №6. s.58-71.
10. Maksimova N.P. Molekulyarnaya genetika. Sbornik zadaniy i testov [Collection of tasks and tests]. M. 2003.
11. Zhimulev I.F. Obshchaya i molekulyarnaya genetika. Novosibirsk [General and molecular genetics]. 2006. 479 s.
12. Kamenskaya M.A. Informatsionnaya biologiya [Information biology]. M. 2006. 344 s. Ratner V. i dr.
13. Minchenko A.G., Dudareva N. Mitokhondrialnyy genom [Mitochondrial genome]. Novosibirsk. 1990. 194 s., 1990, 194 c.
14. Singer M., Berg P. Geny i genomy [Genes and genomes]. T.1.2. M. 1998. T.1-373 s., T.2-391 s..

#### **Additional literature**

1. Aleksandrov A.A. i soavt. Kompyuternyy analiz geneticheskikh tekstov [Computer analysis of genetic texts]. Otv. red. M.D. Frank-Kamenetskiy M..N.1990 g. 264 s.
2. Shabarova Z. A., Bogdanov A. A., Zolotukhin A.S. Khimicheskiye osnovy geneticheskoy inzhenerii [Chemical bases of genetic engineering].
3. Borinskaya S.A., Yankovskiy N.K. Struktura prokarioticheskikh genomov. Molekulyarnaya biologiya [Structure of prokaryotic genomes. Molecular biology]. 1999. tom 33. № 6. s. 941-957.

***Discipline: "Environmental Protection and conservation of biological diversity»***

#### **List of exam topics**

The doctrine of biogeocenoses is a scientific and theoretical basis for studying the stability of ecosystems and the conservation of biodiversity. Vegetation as a component of the ecosystem (biogeocenosis). Part of the autotrophic biota in ecosystems. Phototrophs, their functions and features. Diversity of ecosystems. Environmental factors that disrupt the course of the population cycle and lead to a narrowing of biological diversity. Ecological assessment of the current state of biodiversity. Conducting an inventory of the flora and fauna of a

particular region and protected areas. Principles of drawing up the General and regional cadastre of the animal and plant world; preparation of the red Book publication. Human activities and biodiversity. Inventory of the flora and fauna of a particular region and protected areas. Priorities for the conservation of biological diversity. Long-term monitoring of biological systems. Forecasting ecosystem changes. Goals and objectives of the strategy; strategic directions for the conservation and balanced use of biological diversity. Development of regulatory frameworks for the conservation and balanced use of biological diversity. Organization of a biological monitoring system. Protected areas and biodiversity. Priority actions for the nearest period and completion of the inventory of biodiversity. Inventory of forest ecosystems. The completion of the inventory of flora of mosses. Inventory and publication of the list of algae flora. Key ornithological territories as a basis for conservation and balanced use of birds. Inventory of invertebrates; Handbook of the biodiversity of insects and arachnids in Kazakhstan. Development of a scheme for the development of a network of specially protected territories and the creation of reserves, national parks and Botanical gardens. Conservation of forest ecosystems and balanced use of their components. In-situ conservation of mountain fruit forests in Kazakhstan. Creation of a network of specially protected wetlands of international significance, in accordance with the Ramsar Convention. Principles, scope of jurisdiction, international cooperation in the problem of biodiversity conservation. Improving the legal framework for the conservation and rational use of biological diversity. Improving the economic system for promoting the conservation of biological diversity and developing a framework for the economic assessment of biological resources and standards for their balanced use. Strengthening regional interaction and international cooperation on biological diversity issues. Relationship with other National programmes, conventions and international agreements. Objective of the Rio Convention on biological diversity. Tasks of the Republic of Kazakhstan as a member of the Rio Convention. Inventory of flora and fauna of Kazakhstan. Definition of specially protected natural territories, drawing up a development scheme, organization of reserves, national parks and Botanical gardens. Conservation of biodiversity, conservation priorities. Conservation of agro-diversity of mountain ecosystems in the conditions of in situ. Bringing the biodiversity of ecosystems degraded under the influence of natural and anthropogenic factors to optimal conditions. Security categories. Rational use of bioresources of lakes Balkhash and Alakol, conservation of biodiversity in them, protection from desertification. The conservation of biodiversity of the Caspian sea. National strategy for biodiversity conservation, protection and rational use. Production of germplasm of endangered plant species and endemics of Kazakhstan, preservation in ex situ conditions. Sustainability and dynamics of natural ecosystems. National strategy for the balanced use of biological diversity. Legislative framework for biodiversity conservation. Prospects for the development of biosphere and environmental research.

### **List of recommended literature**

#### **Main literature**

1. Bigaliyev A.B. Problemy okruzhayushchey sredy i sokhraneniya biologicheskogo raznoobraziya [Problems of the environment and conservation of biological diversity]. Uchebnoye posobiye. Almaty. 2005.
2. «Problemy okruzhayushchey sredy i sokhraneniya biologicheskogo raznoobraziya» na russkom yazyke [Problems of the environment and conservation of biological diversity]. Izdatelstvo NURPRESS. 2009g. 260 str.
3. Uchebnik «Obshchaya ekologiya» [General ecology]. Izdatelstvo NURPRESS. 2011g. 150 str.
4. Mirkin B.M., Naumova L.G. Biologicheskoye raznoobraziye i printsipy ego sokhraneniya [Biological diversity and principles of its conservation]. Uchebnoye posobiye. - Ufa. RIO BashGU. 2004. - 124 s.

5. Natsionalnyy doklad Respubliki Kazakhstan ob osushchestvlenii konventsii OON po borbe s opustynivaniyem [National report of the Republic of Kazakhstan on the implementation of the UN Convention to combat desertification]. - Kokshetau. 2000.

6. Gilyarov M.M. Populyatsionnaya ekologiya [Population ecology] M. MGU. 1990.

7. Krasilov V.A. Okhrana prirody: printsipy. Problem [Nature Protection: principles, problems, priorities]. Prioritety. M. 1992.

8. Natsionalnaya programma deystviy po borbe s opustynivaniyem v Respublike Kazakhstan [National action program to combat desertification in the Republic of Kazakhstan]. MEPR. ENEP. Almaty. 1997.

9. Sokhraneniye bioraznoobraziya Tsentralnoy Azii [The conservation of biodiversity in Central Asia]. Kazakhstan. Pod Red. Braginoy T.M., Pereladovoy O.B. Almaty. 1997.

10. Fursov V.I. Ekologicheskiye problemy okruzhayushchey sredy [Environmental problems of the environment]. Alma-Ata. 1991.

#### **Additional literature:**

1. Eskov K.Yu. Istoriya zemli i zhizni na ney [History of the earth and life on it]. M.: MIROS-MAIK "Nauka/Interperiodika" 2000.

2. Perechen redkikh i nakhodyashchikhsya pod ugrozoy ischeznoveniya vidov rasteniy [The list of rare and endangered species of plants]. Utverzhen Postanovleniyem Pravitelstva RK ot 31 oktyabrya 2006 g., №1034. – Astana. 2006. – 9 s.

3. Perechen obyektov okhrany okruzhayushchey sredy. imeyushchikh osoboye ekologicheskoye. nauchnoye i kulturnoye znacheneye [List of environmental protection objects of special ecological, scientific and cultural significance]. Utverzhen Postanovleniyem Pravitelstva RK ot 21 iyunya 2007 goda № 521. – Astana. 2007. -27 s.

4. Kolchinskiy E.N. Evolyutsiya biosfery [Evolution of the biosphere]. Leningrad. "Nauka". 1990.236 s.

5. Problemy. priority i partnerstvo natsionalnogo plana deystviy po okhrane okruzhayushchey sredy dlya ustoychivogo razvitiya Respubliki Kazakhstan [Problems, priorities and partnership of the national action plan for environmental protection for sustainable development of the Republic of Kazakhstan]. Almaty. 1996.

6. Rozanov A.Yu. (red.). Problemy doantropogennoy evolyutsii biosfery [Problems of pre-anthropogenic evolution of the biosphere]. M. 1993.

7. Debelo T.V., Levykin S.V., Chibilev A.A. Strategiya sokhraneniya landshaftnogo i biologicheskogo raznoobraziya v zapadnom sektore Rossiysko-kazakhstanskoy granitsy [Strategy of landscape and biological diversity conservation in the Western sector of the Russian-Kazakh border]. Internet <http://www.mininform.org.ru/books.prigr/deb.nin>.

### ***The course "Cell biology»***

#### **List of exam topics**

Ways of cell evolution and formation of multicellular organisms. Formation of various cellular phenotypes. The main types and diversity of cells. The separation of the functions of cells in multicellular organism, totipotency and cell differentiation. The phenotypes of mammalian cells. Molecular structure and functional components of cell membranes. Types and functions of membrane lipids. Membrane proteins: physical and chemical properties. Molecular organization of membrane transport systems (mobile carriers, ion channels, transport ATPases). Structure of the function of intracellular organelles. Organelles and vesicular transport. Changing the shape of the cells, endo - and exocytosis. Mitochondria and cellular energy. Cell cycle cell division. Vegetative and sexual reproduction of cells. Cell death. Non-programmable and programmable pathways of cell death. Apoptosis. System of

degradation and utilization of intracellular structures. Cytoskeleton. Structure and conformational rearrangements of the cytoskeleton. The main types, molecular organization and Executive mechanisms of systems that provide movement. Motion systems based on polymerization (depolymerization) and interaction of microtubules and actin filaments. Cellular contacts, intercellular adhesion, and extracellular matrix. Molecular mechanisms of signal transmission: the main pathways of intercellular signaling. Phosphorylation and cellular signaling. Cell pathology and aging. Carcinogenesis.

### **List of recommended literature**

#### **Main literature**

1. Chentsov Yu.S. Vvedeniye v kletochnyuyu biologiyu [Introduction to cell biology]. M.: «Akademkniga». 2004.-495 s.
2. Alberts B., Brey D., Lyuis Dzh., Reff M., Roberts K., Uotson Dzh., 1994. Molekulyarnaya biologiya kletki [Molecular biology of the cell]. 1-5 t. M: Mir. 1994.
3. Gennis R. Biomembrany: Molekulyarnaya struktura i funktsii [Molecular structure and functions]: Per. s angl. – M.:Mir. 1997.-624s.
4. Findel Dzh. B., Evanz U.G. Biologicheskkiye membrany [Biological membranes]. Metody: Per. s angl. – M.:Mir. 1990. - 424s.
5. Faller Dzh. M., Shilds D. Molekulyarnaya biologiya kletki. Rukovodstvo dlya vrachey [Molecular biology of the cell]: per. s angl. – M.: Binom - Press. 2004.-272s.
6. Epifanova O.N. Lektsii o kletochnom tsikle [Lectures on the cell cycle]. KMK Scientific press . 1997.

#### **Additional literature:**

1. Svensen K., Uebster P. Kletka [Cell]. M.: Mir. 1980.
2. Zavarzin A.A., Kharazova A.D. Molitvin M.N. Biologiya kletki: obshchaya tsitologiya [Cell Biology: General Cytology]. SPb.: Izd-vo SPb. un-ta. 1992.
3. Skulachev V.P. Energetika biologicheskikh membrane [Energetika biologicheskikh membran]. Moskva. Nauka. 1989 g
4. Skulachev V.P. Energetika biologicheskikh membrane [Energy of biological membranes]. Moskva. Nauka. 1989 g
5. Metsler D. Biokhimiya. Khimicheskkiye reaktsii v zhivoy kletke [Biochemistry. Chemical reactions in a living cell]. Moskva. Mir. 1980 g..t.t. 1-3
6. Spirin A.S. Molekulyarnaya biologiya. Struktura ribosomy i biosintez belka [Ribosome structure and protein biosynthesis]. Moskva. Vysshaya shkola. 1986 g.
7. Alberts B., Bray D., Lewis J., Raff M., Roberts K., Watson J. D. Molecular biology at the cell. 4th ed. N.Y.; L.: Garland Publ., 2001.
8. Karp G. Cell and molecular biology. 2nd ed. N.Y. etc.: John Wiley and Sons, 1996.
9. Lodish H., Besk A., Zipursky S.L., Matsudaira P., Balximore D., Darnell J. Molecular cell biology. 4th ed. L.: Freeman, 2000.
10. Tobin A.J., Murel R.E. Asking about cells. Saunders college publ., 1997.

### ***Discipline " Organization and planning of scientific research»***

#### **List of exam topics**

Scientific research as an activity aimed at a comprehensive study of an object, process or phenomenon, their structure and relationships, as well as obtaining and implementing useful results for a person. Objects of scientific research: material, ideal systems. The subject

of scientific research is the structure of the system, the interaction of its elements, various properties and patterns of development. The methodology of scientific research. History of natural science formation, key stages and aspects. The importance of scientific planning in the modern world. Models and technologies of scientific planning. Diploma work as an independent creative work of students, summarizing the experimental data obtained by them in the course of research work, systematizing their previously acquired theoretical knowledge and providing a platform for mastering the skills of professional presentation, checking their competence in the chosen specialty profile, key elements and requirements for it. The need to use bibliographic references in scientific works, the rules governing it. The concept of copyright and licensing, academic etiquette. Mechanisms for implementing research results. Relevance of the formation of professional and key competencies, over-subject competencies: research (search), organizational and managerial, communicative, reflexive, skills and skills of working in a team. Speech communication as a tool of professional activity. Work with scientific information, its processing and presentation. Technical, graphic, stylistic, grammatical criteria for the design and presentation of the poster, information load. Definition and designation of scientific novelty, relevance, scope of application of research results. Ways and tasks of developing innovative and strategically important scientific technologies. The main stages of science development in Kazakhstan, the strategy "Kazakhstan-2050", state and international programs for financing basic and applied research.

### **List of recommended literature**

#### **Main literature**

1. Aytasheva Z.G. Concise Guidance for Biologists: Preparation of Scientific Publications and Grant Proposals. Kazakh University, 2005, 47 p. (Rus.). and later editions of this guidebook.

#### **Additional literature:**

1. Day R.A. How to write and publish a scientific paper. 4th Edition. Phoenix, Oryx Press AZ, 1994.

2. Woosley J.D. Combating poster fatigue: How to use visual grammar and analysis to effect better visual communications. Trends Neurosci. 12, 325-332, 1989.

3. Dawkins R. The Oxford book of modern writing. 1st paper edition. Oxford University Press, 2009, 419 pp.

4. Issever C., Peach K. Presenting Science. A practical guide to giving a good talk. Oxford University, Press, 2010, 120 pp.

#### **Online resources:**

1. [http://highered.mcgraw-hill.com/sites/0767417399/student\\_view0/chapter1/web\\_links.html](http://highered.mcgraw-hill.com/sites/0767417399/student_view0/chapter1/web_links.html)
2. [http://wps.ablongman.com/long\\_aaron\\_lbb\\_2/22/5789/1482143.cw/index.html](http://wps.ablongman.com/long_aaron_lbb_2/22/5789/1482143.cw/index.html)
3. [http://college.cengage.com/english/chaffee/critical\\_thinking/2e/students/links/chap10.html](http://college.cengage.com/english/chaffee/critical_thinking/2e/students/links/chap10.html)
4. <http://bmj.bmjournals.com/collections/read.htm> (how to read scientific papers)
5. <http://modeling.asu.edu/modeling/weblinks.html> (weblink for the modelers)

**ASSESSMENT SCALE OF THE ENTRANCE EXAM IN THE SPECIALTY  
FOR APPLICANTS TO THE PhD DOCTORAL PROGRAM  
SPECIALTY "8D05101-BIOLOGY"**



Estimation	Evaluation criterion:
Excellent	<ol style="list-style-type: none"> <li>1. This educated, informed and full responses to all theoretical issues</li> <li>2. The practical task is executed in full</li> <li>3. Demonstrated vision and creativity of the student</li> <li>4 .Theoretical postulates are supported by examples.</li> </ol>
Good	<ol style="list-style-type: none"> <li>1. The Answers to all theoretical questions are correct and correct, there are minor inaccuracies, or are not supported by examples</li> <li>2. The practical task is executed but there may be a technical error in the calculations.</li> </ol>
Satisfactory	<ol style="list-style-type: none"> <li>1. Essentially correct answers to all theoretical questions are Given, but either with inaccuracies in the logical sequence, without examples, and with errors in wording</li> <li>2. The practical task is executed with errors or no</li> </ol>
Unsatisfactory	<ol style="list-style-type: none"> <li>1. The answer is not given, or contains serious errors.</li> <li>2. Broken a logical sequence.</li> <li>3. The practical task is not done.</li> </ol>

The maximum score is 100 points, and the minimum (passing) score is 51 points.

1 question (theoretical) is evaluated as follows:

Excellent – 30 points (maximum)

Good – 26 points (maximum)

Satisfactory - 23 points (maximum)

Unsatisfactory - 15 points (maximum)

2 question (theoretical) is evaluated as follows:

Excellent – 30 points (maximum)

Good – 26 points (maximum)

Satisfactory - 23 points (maximum)

Unsatisfactory - 15 points (maximum)

3 question (practical) is evaluated as follows:

Excellent-40 points (maximum)

Good – 35 points (maximum)

Satisfactory - 30 points (maximum)

Unsatisfactory - 20 points (maximum)