**AL-FARABI KAZAKH NATIONAL UNIVERSITY**

**Faculty of Biology and Biotechnology**

**Department of Molecular Biology and Genetics**

**FINAL EXAM PROGRAM**

**«Genetics»**

**Specialties «6B05101 – Biological Engineering»**

Course – 2

Semester – 3d

Number of credits – 3

Almaty, 2023

Final Exam Program of the discipline «General genetics» of educational program «**6B05101 – Biological Engineering**» developed by Djansugurova L.B., PhD, Full professor, professor of department molecular biology and genetics

Considered and recommended at the department meeting of Molecular Biology and Genetics

On \_\_\_\_\_\_\_\_\_, \_\_\_, 2023, protocol № \_\_\_.

Head of the Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Zhunusbayeva Zh.K.

Considered and recommended by methodological council of the Faculty of Biology and Biotechnology

On \_\_\_\_\_\_\_\_\_, \_\_\_, 2023, protocol № \_\_\_.

Chair of the bord, c.b.sc. \_\_\_\_\_\_\_\_\_\_\_\_\_ Asrandina S.Sh.

**The form of Final exam is online testing using the IS UNIVER.**

will be held in test manner online (комплект тестов #4027). It is totally prohibited to use any electronic devices during the exam, and cheat. More details will be given asap. The 100 point system will be used for estimation of the final exam results.

**The aim** of testing is to assess the knowledge of students and their ability to apply their knowledge in solving practical problems, to navigate in the information space, check the level of formation of analytical, research skills in discipline and creative thinking.

**The order and rules of Final exam:**

On the Exam day, according to the schedule, each student will receive a test task, including **40 questions with multiple answers**.

Time to answer and save test results - **90 minutes**.

**Steps of Final exam:**

1. Obtaining a test task
2. Solving and completing the task.

3. Saving answers in the "UNIVER" system.

**Criteria for grade:**

А (90-100%) - the student has thoroughly studied the educational material; consistently and exhaustively answers the questions posed; freely applies the received knowledge in practice.

B (75-89%) - the student knows the educational material; does not allow serious errors when answering; he can apply the received knowledge in practice.

C (60-74%) - the student knows only the basic material; on the questions asked is not sufficiently clear and complete.

D (50-59%) - the student has separate ideas about the material studied; can not fully and correctly answer the questions posed, when answering, he makes gross mistakes.

During the exam, **the proctoring is provided**.

The Exam tests are in accordance with discipline content.

The Exam tests will not be giving to the students before the final exam.

But questions according to main modules for preparing to the final exam tests are provided.

**Topics for preparing to the Exam tests:**

**Module 1. Introduction to Genetics**

1. The subject of genetics. Objects and methods of Genetics. Practical and theoretical significance of genetics. Categories of heredity and variability.
2. The history of genetics. Branches of genetics. The main theoretical problems of Genetics. Application of genetics.
3. The cell theory establishment and its significance for development of genetics. Cytological basis of heredity. Mitosis and meiosis. Gametogenesis and sporogenesis.
4. Basic concepts of genetics: "genotype", "phenotype", "gene", "allele", "homozygosity" "heterozygosity" "hemizygosity" and "mutation".
5. The method of crossing. The types of crosses. Genetic symbols.
6. Gregor Mendel's paper “Experiments on Plant Hybridization”.The significance of this work for genetics.

**Module 2. Principles of inheritance and the Mendelian genetics laws**

1. Monohybrid crosses. Mendel’s laws for monohybrid crosses.
2. Alleles. The interactions between alleles. The modifications of dominance relationships: complete dominance, incomplete dominance, codominance. Multiple alleles, subdominance.
3. The cytological evidences of 2d Mendel’s principle of gametes purity and segregation of F2 progeny.
4. Dihybrid crosses. Mendel’s law for dihybrid crosses. Ratio of F2 progeny phenotypes and genotypes.
5. Trihybrid and polyhybrid crosses. The splitting formulas for F2 phenotypes and genotypes. The cytological evidence of gametes independent assortment.
6. Test cross. The significance of test crosses for genetic analysis. Tetrad analysis. Pedigree analysis.

**Module 3. Inheritance and variability**

1. Non-allelic genes. Non-allelic gene interactions.
2. Complementary gene interaction. The possible splitting formulas.
3. Epistasis. Dominant and recessive epistasis. The epistasis possible splitting formulas.
4. Polymerism. Cumulative (additive) and non-cumulative (non-additive) polymerism. Transgression.
5. The statistic analysis of progeny splitting. The Chi-Square Test.
6. Causes of deviations from the probabilistic splitting. Lethal genes.
7. The interactions between genes and environmental factors. Genes-modifiers.
8. Variation in Gene Expression. Penetrance. Expressivity. Pleiotropy.
9. Sex determination. The types of sex determinations: singamic, progamic and epigamic.
10. Sex chromosomes and autosomes. The types of chromosomal sex determination.
11. Inheritance of sex-linked traits.
12. Nondisjunction of X-chromosomes. Primarily and secondary nondisjunction of chromosomes.
13. Bridges’s Balance theory of sex determination. Intersexes. Gynandromorphs.
14. Dose compensation mechanisms. Sex chromatin. Sex Chromosome Abnormalities in Human.
15. Haplodiploidy. Sex regulation. The methods of early sex determining.
16. The significance of T. Morgan school researches. Phenomenon of linked inheritance and methods of it’s analysis.
17. Crossing over. Genetic evidence of crossing over.
18. The cytological evidence of crossing over.
19. Single and multiple crossing over events. Interference and coincidence.
20. Somatic crossing over. Unequal crossing over. Factors influencing on the crossing over frequency.
21. Chromosomes and linked groups. Linked group determining. Genes localization. Creating of chromosome genetic maps.
22. The statements of chromosome theory.

**Module 4. Variability of genetic material, molecular genetics view.**

1. Structure and function of DNA and RNA. The significance of DNA replication in heredity phenomenon.
2. Evolution of the gene ideas. Fine structure of pro-and eukaryotes genes. Differences between the genes of pro-and eukaryotes.
3. The basic principles of gene expression. The mechanisms of transcription and translation. The genetic code. Properties of the genetic code.
4. The value of repair in heredity and variability of organisms. Mechanisms of DNA damage repair.
5. Heredity and variability at different levels of life organization (viruses, prokaryotes, eukaryotes). Evolutionary significance of heredity and variability.
6. Extra-nuclear inheritance. Methods for studying the role of the nucleus and cytoplasm in the phenomena of heredity.
7. Plastid inheritance. Inheritance of spotted colored trait in plants.
8. Mitochondrial heredity. Cytoplasmic male sterility. Maternal effect.
9. Mobile elements and their role in the occurrence of spontaneous mutations
10. Variability of genetic material. Forms of variability and character of genotype changes. Hereditary and non-hereditary variability.
11. Modification variability. Norm reaction of trait. Adaptability of modifications. Morphosis.
12. Stages of development of the mutation theory. The main statements of the mutation theory.
13. N.I Vavilov’s principle of homologous series of hereditary varibility.
14. The classification of mutations. Classification of mutations by Henry Muller. Classification of mutations based on the character of genotype changes.
15. Genomic mutation. The main types of genomic mutations.
16. Polyploidy. Types of polyploidy. Experimental methods for producing of polyploid organisms. Aneuploidy (Geteroploidiya). Autopolyploids and allopolyploids.
17. Types of chromosomal mutations. Gene mutations. Frame-shift mutation and base pair substitutions.
18. Spontaneous and induced mutagenesis. Forward and reverse mutations. Factors causing hereditary variability.
19. Radiation mutagenesis. Radiosensitizers and radioprotectors. Mutagenic effect of UV rays.
20. Chemical mutagenesis. The mechanism of basic chemical mutagens (nucleotide base analogs, nitrous acid, alkylating agents, nitroso, acridine, etc.) actions.
21. Balanced chromosomes. Methods for quantifying of mutations (CLB method, Muller 5, etc.).

**Module 5. Basics of population genetics and selection process.**

1. Species and populations. Panmictic population.
2. The Hardy-Weinberg equilibrium, the possibility of its application. Factors that violate the balance of genes in populations.
3. Natural selection as a guiding factor in the evolution of the population. Form of natural selection. Genetic drift and isolation as necessary factors of evolution.
4. Genetics and breeding (selection). Definitions of breeding. Artificial selection. Unconscious and methodical selection.
5. Mating system in the breeding of plants and animals. Inbreeding. Outbreeding.

**Literature for preparation to the Exam tests**

**Literature:**

1. Emery and Rimoin's. Principles and Practice of Medical Genetics and Genomics. Perinatal and Reproductive Genetics. Edited by Reed E. Pyeritz, Bruce R. Korf, Wayne W. Grody. Seventh edition. Ebook. English, Elsevier Academic Press, 2022
2. [Bahar Taneri](https://worldcat.org/search?q=au=%22Taneri%2C%20Bahar%22).  Human genetics and genomics: a practical guide. Wiley-VCH, Weinheim, Germany, 2020. 142 p.
3. William S Klug, Michael A Palladino, Michael R Cummings, Charlotte A Spencer. Concepts of Genetics. Global Edition 12th Edition. Pearson – 2019.
4. Matthew W. Hahn Molecular Population Genetics. Publisher:Sinauer Associates is an imprint of Oxford University Press; 1st edition. 2018. 352 pages

1. [McKinsey L. Goodenberger](https://worldcat.org/search?q=au=%22Goodenberger%2C%20McKinsey%20L.%22), [Brittany C. Thomas](https://worldcat.org/search?q=au=%22Thomas%2C%20Brittany%20C.%22), [Teresa Kruisselbrink](https://worldcat.org/search?q=au=%22Kruisselbrink%2C%20Teresa%22), Practical genetic counseling for the laboratory. [Oxford University Press](https://worldcat.org/search?q=au=%22Oxford%20University%20Press%22). 2017. 383 p.
2. Hartwell, Leland Hartwell, Michael Goldberg, LeRoy Hood, Charles Aquadro. Genetics: From Genes to Genomes. 5th edition. Publisher: McGraw-Hill Education (05.09.2014). Copyright: 2015
3. Anthony JF Griffiths, Susan R Wessler, Sean B Carroll, John Doebley. An Introduction to Genetic Analysis. 11th edition. Publisher: W. H. Freeman (12.01.2015) Copyright:2015
4. D. Peter Snustad, Michael J. Simmons. Principles of Genetics, 7th Edition. 2015. 683 pages
5. Thompson & Thompson Genetics in Medicine (Thompson and Thompson Genetics in Medicine) 8th Edition // Elsevier – 2015.
6. Benjamin A. Pierce. Genetics: A Conceptual Approach. 5th edition. Publisher:W. H. Freeman. Copyright: 2014
7. Клаг Уильям С., Каммингс Майкл Р. Мир биологии и медицины: Основы генетики // Москва: Техносфера. 4-е издание. 2009. 896 с.
8. Daniel L. Hartl. Essential of genetics: A Genomics Perspectives. Sixth Edition. Jones and Bartlett Publishers. Sudbury, Massachusetts. USA. 2012.
9. Daniel L. Hartl. Essential of genetics: A Genomics Perspectives. Sixth Edition. Jones and Bartlett Publishers. Sudbury, Massachusetts. USA. 2006.
10. Thompson & Thompson Genetics and Genomics in Medicine Elsevier eBook on VitalSource, 9th Edition by Ronald Cohn, Stephen Scherer and Ada Hamosh// Copyright: Imprint: Elsevier. 2023. 570 p.
11. [Patricia McCarthy Veach](https://worldcat.org/search?q=au=%22Veach%2C%20Patricia%20McCarthy%22) (Author), [Bonnie S. LeRoy](https://worldcat.org/search?q=au=%22LeRoy%2C%20Bonnie%20S.%22) (Author), [Dianne M. Bartels](https://worldcat.org/search?q=au=%22Bartels%2C%20Dianne%20M.%22) Facilitating the Genetic Counseling Process: a Practice Manual. Springer-Verlag, New York, Ebook. 2003. 318 p.
12. Генетика человека с основами медицинской генетики: Среднее медицинское образование /. Рубан Э.Д. - Москва: Феникс, 2020 - 319 c.
13. Генетика: краткий курс лекций для студентов 2 курса направления подготовки 35.03.04 «Агрономия» / Ю.В. Лобачев // ФГБОУ ВО Саратовский ГАУ. – Саратов, 2016. – 85 с.
14. Основы генетики человека: учебное пособие / Г. Л. Снигур, Т. Н. Щербакова, Э. Ю. Сахарова. – Волгоград: Изд-во ВолгГМУ, 2017. – 120 с.

**Internet-resources:**

1. Genetics // Written by A.M. Winchester. Last Updated: 2023 [https://www.britannica.com/science/genetics](https://www.britannica.com/science/genetics/Microbial-genetics)
2. <https://www.amnh.org/explore/ology/genetics/what-is-genetics>
3. Daniel L. Hartl and Elizabeth W. Jones. Genetics. Principles and Analysis. Forth Edition. Jones and Bartlett Publishers. Sudbury, Massachusetts. USA. 1998, 2008. - 1367 p. <http://www.agrimoon.com/wp-content/uploads/Principle-of-Genetics.pdf>
4. Russel P. Fundamentals of Genetics. 5th Edition. New York, Reed College, 1998 <https://www.pearson.com/us/higher-education/program/Russell-Genetics-5th-Edition/PGM129280.html>
5. The New Genetics. U.S. Department of Health and Human Services. National Institutes of Health National Institute of General Medical Sciences. NIH Publication No.10 662. Revised April 2010. http://www.nigms.nih.gov
6. <https://medlineplus.gov/genetics/understanding/>
7. <https://www.cdc.gov/genomics/about/basics.htm>
8. Костерин, О. Э. (2022). Основы генетики: учебник. (2-е, перераб. ред.) ИПЦ НГУ. <https://doi.org/10.25205/978-5-4437-1323-6>
9. https://elibrary.kaznu.kz/ru/

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