

AL-FARABI KAZAKH NATIONAL UNIVERSITY
Faculty of Medicine and Healthcare, Higher School of Medicine
Department of Fundamental Medicine

PROGRAM
of final exam by the discipline
OTMF96138 “Omics” technologies in medicine and pharmacy - 5 ECTS

Expected outcomes:

Students in the final exam must demonstrate the ability to:

1. have an idea of the modern "omics" technologies;
2. correctly choose one of the research methods for solving the stated experimental and theoretical problems;
3. describe “proteomics”;
4. highlight signs and draw conclusions on protein microchips, etc.;
5. classify "Omics" technologies in the context of clinical diagnosis;
6. to find the relationship between omics technologies and personalized medicine;
7. demonstrate knowledge of the use of omix technologies;
8. describe a group of monogenic and multifactorial diseases;
9. understand the methods for obtaining and analyzing experimental data.

Approved final exam form - written exam

Topics included in final exam:

1. Introduction to “Omics” technologies.
2. Structural genomics. Human genome.
3. Functional genomics.
4. Epigenomics.
5. Farmacogenomics.
6. Genomic methods of research and diagnostics.
7. Transcriptomics. Methods of transcriptome investigation.
8. Proteomics and methods of proteome investigation.
9. Interactomics (the research of protein-protein interactions).
10. Glycomics.
11. Lypidomics.
12. Regulomics and metabolomics.
13. Bioinformatics.
14. Personalized medicine (the future of medicine).
15. The development of new drugs by using the omics technologies.

Questions

1. Explain, how you understand the term "Omics" technologies? Give the definition of this term.
2. Describe the main Omics technologies, their methods and the connections between them.
3. Describe the application of Omics technologies in medicine and pharmacy, their perspectives in the Future.
4. Give the definition to the following terms: "gene", "genotype", "genome", "genetics" and "genomics".
5. Characterize the differences between structural and functional genomics, give the definitions.

6. Describe the history of the Human Genome Project. What is the meaning of this project?
7. Analyze the applications of the results of this project in medicine and pharmacy, their future perspectives.
8. Briefly describe the structure of human genome.
9. Give the definition to the following terms: functional genomics, genome organization, informational capacity of the genome, informational density of the genome.
10. Characterize the different types of genes by their functions, give the specific examples.
11. Explain how the human genome encodes 100 thousands proteins if it contains only 25-30 thousands of genes?
12. Compare the genomes of several absolutely different organisms with the human genome by their structure and informartional properties, analyze the differences and similarities.
13. Describe the mechanisms of gene expression: transcription, post-transcriptional modyfications, translation and post-translational modyfications of proteins.
14. Explain the difference between the terms “genetics” and “epigenetics”, “genomics” and “epigenomics”.
15. Explain the term “gene expression” and different mechanisms of inheritance.
16. Describe the mechanisms of gene expression regulation on the transcriptional and post-transcriptional level in procaryotes and eucaryotes.
17. Characterize the histone modifications and their influence on gene expression.
18. Explain the mechanisms of environmental influence on gene expression.
19. Explain the difference between the terms “farmacogenetics” and “farmacogenomics”.
20. Characterize the mechanisms of genetically based human reactions to the medical drugs, give the specific examples.
21. Describe the methods of farmacogenomics.
22. Analyze Sanger and Maxam-Gilbert methods of DNA sequencing.
23. Compare Sanger method with several methods of Next Generation Sequencing (NGS), analyze their advantages and disadvantages.
24. Describe “short gun-sequencing” and “chromosome walking” methods of genome sequencing.
25. Characterize bioinformatical methods of genome analysis (genome assembling, genome annotation, finding of open-reading frames (ORFs) and prediction of genes, alignment of nucleotide sequences, protein structure prediction and etc.). Give specific examples of used programs and bioinformatical databases.
26. Explain the main traditional methods of molecular biology that are used in genomic research: polymerase chain reaction (PCR), gel-electrophoresis, northern blotting, Southern blotting, restriction analysis and etc.
27. Describe the methods of DNA genotyping, DNA diagnostics, DNA fingerprinting and DNA microarray.
28. Give the definition to the following terms: “transcript”, “transcriptome”, “transcriptomics”, “gene expression profile”.
29. Describe and analyze the different types of RNA by their structure and functions.
30. Explain the methods of different RNA extraction, amplification and sequencing.
31. Explain how the methods of gene expression profiling, RNA microarray and RNA-seq can be used for diagnostics of different diseases?
32. Give the definition to the terms “olygopeptides”, “polypeptides”, “proteins”, “proteome”, “proteomics”.
33. Explain and analyze the experimental methods of proteomics: MALDI-mass-spectrometry, ESI-mass-spectrometry, different types of chromatography, 2D- and 3D-PAGE, ELISA, nuclear magnetic resonance (NMR), X-ray diffraction and etc. What are the reasons for selecting any of these methods for specific proteins?

34. Describe the computational (bioinformatical) methods of protein research: amino acid sequence alignment, protein structure prediction, analysis of X-ray diffraction pattern and 3D-modelling of protein structure.
35. Characterize the Protein Data Bank (PDB), Uni-ProtKB/Swiss-Prot and other bioinformatical databases of protein information.
36. Give the definition to the terms “interactome” and “interactomics”.
37. Characterize the experimental methods of interactomics: yeast two-hybrid system (Y2H-assays), phage display, solid phase affinity chromatography, molecular fishing on the chip of optical biosensor, mass-spectrometry and microscopic methods. Give the specific examples.
38. Analyze and compare the bioinformatical methods of interactomics: phylogenetic trees, interaction networks and etc.
39. Give the definitions to the following terms: “carbohydrates”, “monosacharids”, “disacharids”, “polysacharids”, “glycome” and “glycomics”, give the specific examples.
40. Analyze the chemical structure and fuctions of different carbohydrates, give the specific examples.
41. Describe the chemical structure and function of glycoproteins and proteoglycans.
42. Explain how some glycoproteins (lectins) can participate in cellular recognizing, adhesion and interactions between the cells (so called “sugar code”)?
43. Explain different disturbances of carbohydrate metabolism and methods of their diagnostics and treatment, give the specific examples.
44. Give the definition to the terms “lipids”, “lypoproteins”, “lypidome”, “lypidomics”.
45. Analyze the different types of lypids by their chemical structure and function, give the specific examples.
46. Explain the methods of lypidomic research.
47. Explain different disturbances of lypid metabolism and methods of their diagnostics and treatment, give the specific examples.
48. Give the definition to the terms “metabolites”, “metabolism”, “regulome”, “regulomics”, “metabolome”, “metabolomics”.
49. Explain the mechanisms of enzyme activity regulation, give the specific examples.
50. Briefly describe the metabolism of all organic and non-organic substances in human organism (metabolism of proteins, carbohydrates, lypids, minerals, salts and water) and its regulation (hormonal, neural and biochemical).
51. Characterize the methods of research the metabolism.
52. Explain how metabolic disturbances diseases connected with different human diseases, give the specific examples.
53. Explain the terms “bioinformatics”, “computational biology” and “system biology”.
54. Analyze the bioinformatical methods used in different “Omics” technologies, give the specific examples.
55. Explain the differences between structural, functional and evolutionary bioinformatics.
56. Give and describe the examples of bioinformatical computer programs used for different tasks.
57. Classify and describe the main bioinformatical databases, give the specific examples.
58. Give the definition to the terms “personalized medicine”, “gene therapy”, “target delivery”, “nanoparticles”, “nanotechnology”.
59. Explain how the omics technologies can be used for individual diagnostics, treatment and profilactics of human diseases?
60. Analyze the modern and future methods of biomedicine used for treatment of human diseases (nanotechnology, biocompatible polymers, artificial tissues and organs, using the stem cells, radiation oncology and etc.). What are their dangers and perspectives?
61. Characterize the methods of gene therapy “*ex vivo*” and “*in vivo*”, give the specific examples.

62. Analyze the perspectives and dangers of human genome editing, its bioethical consequences.
63. Explain the each step of the drug development by using different “omics” technologies, give the specific examples.

For passing the exam in written/oral form:

The example of ticket:

1. Describe the main Omics technologies, their methods and the connections between them.
2. Analyze the modern and future methods of biomedicine used for treatment of human diseases (nanotechnology, biocompatible polymers, artificial tissues and organs, using the stem cells, radiation oncology and etc.). What are their dangers and perspectives?

Response Quality Scale

The mark	Criteria	The scale, points
excellent	<ol style="list-style-type: none"> 1. all key aspects included and presented logically; 2. high accuracy (relevance, without redundancy) and consistent focus on question; 3. excellent integration of theoretical issues; 3. provision of relevant examples; 4. in-depth analysis and theoretical justification of given problem (if applicable), all key aspects identified and interpreted; 5. fluency in use of professional terminology 	90 - 100
good	<ol style="list-style-type: none"> 1. all key aspects included and presented logically; 2. consistent focus on question with satisfactory accuracy, and relevance, and/or some redundancy; 3. satisfactory integration of theoretical issues; 3. lack of examples; 4. satisfactory analysis and theoretical justification of given problem (if applicable), most key aspects identified and interpreted; 5. correct use of professional terminology 	75 - 89
satisfactory	<ol style="list-style-type: none"> 1. most key aspects included; 2. satisfactory focus on question - some lapses of relevance and/or noticeably redundancy; 3. theoretical issues presented without noticeably integration; 3. provision of unsuccessful examples or no examples; 4. some analysis and theoretical justification of given problem (if applicable), most key aspects identified and interpreted; 5. correct use of professional terminology 	50 - 70
unsatisfactory (FX)	<ol style="list-style-type: none"> 1. most key aspects missed; 2. lack of focus on question - no relevance and notable redundancy; 3. some theoretical issues presented in some way; 3. no or irrelevant examples; 4. some analysis and theoretical justification of a given problem (if 	25 - 49

	applicable), most key aspects missed; 5. lapses in use of professional terminology	
failed	1. most or all key aspects missed; 2. no focus on question, irrelevant information; 3. theoretical issues missed or superficial; 3. no or irrelevant examples; 4. no analysis and no theoretical justification of a given problem (if applicable), most key aspects missed; 5. lapses in use of professional terminology	0-24

The system of marks

Alphabetic Grading System	Numeric Equivalent	Score (percentage)	Traditional Grading System
A	4,0	95-100	Excellent
A-	3,67	90-94	
B+	3,33	85-89	Good
B	3,0	80-84	
B-	2,67	75-79	
C+	2,33	70-74	
C	2,0	65-69	Satisfactory
C-	1,67	60-64	
D+	1,33	55-59	
D-	1,0	50-54	
FX	0,5	25-49	Unsatisfactory
F	0	0-24	
I (Incomplete)	-	-	“The discipline has not been completed” <i>(is not taken into account during the GPA calculation)</i>
P (Pass)	-	-	“The discipline has been passed” <i>(is not taken into account during the GPA calculation)</i>
NP (No Pass)	-	-	“The discipline has not been passed” <i>(is not taken into account during the GPA calculation)</i>
W (Withdrawal)	-	-	Refusal from the discipline <i>(is not taken into account during the GPA calculation)</i>
AW	-	-	Withdrawal from the discipline by

(Academic Withdrawal)			academic reasons (is not taken into account during the GPA calculation)
AU (Audit)	-	-	The discipline has been listened (is not taken into account during the GPA calculation)
Att.	-	30-60 50-100	Attestated
Not att.	-	0-29 0-49	Not attested
R (Retake)	-	-	Retake for the discipline

**A WRITTEN EXAM:
TRADITIONAL - ANSWERS TO QUESTIONS.**

It is carried out on the external resource of Oqylyq LMS. The exam format is synchronous.

The process of passing a written exam by a student involves the automatic creation of an examination card for a student, to which it is necessary to form a written answer by directly entering the text into the system

Exam technology instruction

1. The exam duration is exactly **2 hours**
2. At the specified time, the student visits the "app.oqylyk.kz" website.
3. The student receives the login and password in the IS Univer.
4. Generation of a ticket for each student is made automatically.
5. The exam begins with **obligatory proctoring**: a laptop or home computer with a webcam is required. If it is not available, you can use the smartphone camera, for example, with the "DroidCam client" application.
6. The answer is printed in the field of the program **OQYLYQ. NOT PROVIDED** for a handwritten response form on a piece of paper
7. Upon completion of the exam, the student clicks the "Finish" button.

Basic literature:

1. Mambetpayeva, B. S. Basics of Biomedicine: training aid / B. S. Mambetpayeva ; Ministry of Health of the Republic of Kazakhstan. - Astana : Ақһұр, 2017. - 197 p. - URL: <http://elib.kaznu.kz/order-book>. - ISBN 978-601-7894-91-7
2. Beketayeva, Assel Orozaliyevna. Mathematical Modeling of the Biomedical Processes : study book / A. O. Beketayeva ; Al-Farabi Kazakh National University. - Almaty : Qazaq University, 2018. - 106 p. : il. - URL: <http://elib.kaznu.kz/order-book>. - Bibliogr. at the end of sections. - 100 (circulation) экз. - ISBN 978-601-04-3730-2
3. Genetics : textbook / D. K. Aydarbaeva, K. K. Muhambetzhonov, Z. S. Kenzhebaeva [et al.] ; Ministry of Education and Science of the Republic of Kazakhstan. - Almaty : Association of Higher Educational Institutions of Kazakhstan, 2016. - 243 p. : il. - URL: <http://elib.kaznu.kz/order-book>. - Bibliogr.: p. 229-230. - 1000 (circulation) экз. - ISBN 978-601-217-586-8
4. Zhussupova, Aizhan Izbasarovna. PCR – Diagnostics : educational manual / A. I. Zhussupova ; Al-Farabi Kazakh National University. - Almaty : Qazaq university, 2016. - 127, [1] p. - URL: <http://elib.kaznu.kz/order-book>. - Bibliogr.: p. 124. - ISBN 978-601-04-1237-8

5. Nanobiotechnology: inorganic Nanoparticles vs Organic Nanoparticles / Instituto de Nanociencia de Aragon-ARAID, Universidad de Zaragoza ; ed. by J. M. de la Fuente, V. Grazu. - Amsterdam ; Boston ; Heidelberg : Elsevier, 2012. - 520 p. : il. - (Frontiers of Nanociencia. Vol. 4). - URL: <http://elib.kaznu.kz/order-book>. - Ind.: p. 509-520. - ISBN 978-0-12-415769-9

Additional literature:

1. Vlahou et al. Integration of Omics Approaches and Systems Biology for Clinical Applications / 2018 John Wiley & Sons, Inc. – 382 p.
2. Yu Liu. OMICS in Clinical Practice / 2014 by Apple Academic Press, Inc. – 456 p.
3. Barh D., Blum K., Madigan M.A. OMICS. Biomedical Perspectives and Applications / 2012 by Taylor & Francis Group, LLC. – 516 p.
4. Clark, David P. Biotechnology: Applying the Genetic Revolution : textbook / D. Clark, N. Pazdernik. - Amsterdam ; Boston ; Heidelberg : Elsevier, 2009. - 762 p. - URL: <http://elib.kaznu.kz/order-book>. - ISBN 978-0-12-175552-2

Internet resources:

1. Lecturio.com
<https://www.lecturio.com>
2. Taylor and Francis Online
<https://www.tandfonline.com/action/doSearch?AllField=omics&SeriesKey=iedc20&pageSize=10&subjectTitle=&startPage=0>
3. “Human Genome” Project
https://web.ornl.gov/sci/techresources/Human_Genome/project/info.shtml
4. NCBI - The National Center for Biotechnology Information, USA
<https://www.ncbi.nlm.nih.gov/>
5. NDB - a portal for three-dimensional structural information about nucleic acids
<http://ndbserver.rutgers.edu/>
6. OMIM - compendium of human genes and genetic phenotypes
<https://www.ncbi.nlm.nih.gov/omim?db=OMIM>
7. Ensembl - Genome browser for vertebrate genomes <http://asia.ensembl.org/index.html>
8. EMBL-EBI - European Bioinformatics Institute
<https://www.ebi.ac.uk/>
9. Video lectures by Molecular Biology:
<https://www.khanacademy.org/>
10. Coursera
<https://www.coursera.org/>