INTERNATIONAL HIGHER SCHOOL OF MEDICINE

Department of Natural Sciences Disciplines

SYLLABUS

Genomic technologies in medicine

2025-2026 academic year for
students of medical faculty
2 course 3 semester, groups 1,2,3,9,19,20,21
1 credit (36 h, including auditorial 18 h, independent work – 12 h)

Lecturer: **Khudaibergenova Bermet Merlisovna**
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Venue: Zoom

Practical classes: **Khudaibergenova Bermet Merlisovna**
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Venue: #417 of Administrative building of IHSM, 4th floor

The Syllabus is considered
at the meeting of the department of Natural Sciences Disciplines
Protocol №2 dated 15.09.2025
Head of the department _____ Ch. S. Ismailova

Course Objective: Expanding the understanding of the theoretical and applied significance of modern genetics as an important component in the system of natural science, mastering the principles of using genomic technologies in genome decoding, gene modification, diagnosis and treatment of a number of diseases.
After study of the discipline the student must:
Knowledge: the main mechanisms of transmission of genetic information, the functions and role of biomolecules in the implementation of the genotype at the phenotype level
Skill: to build a replicative strand of DNA, RNA, to select methods for the diagnosis of the disease
Attitude: principles of operation of modern genomic technologies used in medicine

Pre-requisites. to understand the content of the course, the student must have the knowledge acquired in the first year:
• Medical Biology, genetics and Parasitology
• General physics
• General Chemistry
Post-requisites. Medical genetics, • Bioethics

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THEMATIC PLAN OF LECTURES

№	Theme of lecture	Hours	Date
1	Current trends in the study of the genome	2	06.09.25
2	The human genome. Unique and repetitive sequences.	2	13.09.25
3	Epigenetics and epigenetic effects in humans	2	20.09.25
4	Genomic technologies in therapy	2	27.09.25

THEMATIC PLAN OF PRACTICAL CLASSES

№	Theme of practical class	Hours	Date
1	A retrospective of the use of labels for cellular structures	2	06 - 13.09.25
2	Defects of metabolic pathways. Causes and consequences	2	20 - 27.09.25
3	Modern methods for detecting DNA damage at the structural level	2	04 - 11.10.25
4	Methods for detecting DNA damage at the molecular level	2	18 – 25.10.25
5	Module	2	01 - 08.11.25

THEMATIC PLAN OF INDEPENDENT WORK OF STUDENTS

№	Theme of independent work	Hours	Date
1	The use of radioactive molecules in biology experiments	3	06 - 13.09.25
2	Decisions of tasks on DNA size and mass estimation	3	20 - 27.09.25
3	Transcription and translation processes	3	04 - 11.10.25
4	Genetic code, realization of hereditary information on the protein level	3	18 – 25.10.25

Recommended reading for the discipline:

1. Basic:
   1. Genomic and precision medicine: Foundations, translation and implementation. Geoffrey S. Ginsburg, HuntingtonF. Willard. 2017, Elsevier.
   2. Genetics and Genomics in medicine. T. Strachan, An. Lucassen. 2022. CRC Taylor& Fransic Group.
2. Additional:
   1. A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution. Jennifer Doudna & Samuel H. Sternberg
   2. The $1,000 Genome: The Revolution in DNA Sequencing and the New Era of Personalized Medicine. Kevin Davis. 2010.
   3. The Epigenetics Revolution. Nessa Carey, 2013.
   4. Genomic technologies—from tools to therapies. Andreia Cunha// Genome Medicine. volume 9, Article number: 71. 2017

Grading policy and procedures for all types of work
For the period of studying the discipline, the student gains points for the relevant parameters (per unit):
current score - 40 points
independent work - 20 points

control score (final assessment of knowledge per unit) - 40 points
Maximum score - 100 (40+20+40)

Grading system for student's achievements

Grading criteria per discipline				
Maximum score	Intervals			
	«unsatisfactory»	«satisfactory»	«good»	«excellent»
Current control - 40	0-23	24-30	31-35	36-40
Interval description	The student does not know a significant part of the program material, makes significant blunders; the main content of the material is not disclosed; poor knowledge of terminology; there is no necessary theoretical knowledge and the ability to apply them to solve practical problems. It is also marked "unsatisfactory", in case the student refuses to answer	The student has mastered only the basic program material, but does not know individual features and details; admits inaccuracies; violates the sequence in the presentation of the program material; the material is not systematized, incorrectly formulated; speech is mostly literate, but poor; has a minimum sufficient level of competence; solves professional practical problems with errors, mainly justifies	The student has demonstrated the level of competence formation, has a sufficient level of professional terminology; correctly, logically and essentially sets out the answer, does not allow significant errors and inaccuracies in answering questions, but the presentation is sufficiently systematic and consistent; when solving a practical problem, basically justifies the decisions made correctly	The student has demonstrated the formation of competencies and can apply them in professional activities; exhaustively, consistently, competently and logically harmoniously presents the answer, without errors; the answer does not require additional questions; good speech, fluency in professional terminology; does not have difficulties in answering when changing assignments; knows how to solve professional practical tasks; justifies the decisions made correctly, is able to summarize and present the material independently
Independent work - 20	0-11	12-15	16-17	18-20
Interval description	The student has not considered any question of the IWS (main and/or additional) to the end. The student refused to prepare the IWS.	The student has the necessary educational material within the framework of the program, but the answers to the questions are not complete and accurate enough; only data from the main literature on the	The student has studied the basic and is familiar with additional literature on the program and uses this knowledge when answering; in the process of answering additional questions, the	The student has studied the main and additional literature on the subject and competently uses the acquired knowledge when answering; in answers, uses course materials from related disciplines,

		discipline is used in the answer	material is presented correctly, but without sufficient logical sequence; when answering, he uses the necessary, neatly executed graphic material (diagrams, drawings, etc.); to clarify the answers, sometimes leading questions from the teacher are required.	provides various examples as justification; during the preparation process, at a high level, performs the necessary diagrams and charts and uses them when answering; does not need any help from the teacher; strives to independently replenish and update the knowledge necessary in professional activities.
Control work (module) - 40	0-23	24-30	31-35	36-40
Interval description	The student has identified gaps in the knowledge of the educational material provided by the program, can not give clear answers to basic, additional and leading questions.	The student has the necessary educational material within the framework of the program, but the answers to the questions are not complete and accurate enough; only data from the main literature on the discipline is used in the answer	The student fully discloses the educational material provided by the program; minor errors (inaccuracies) have been made that do not distort the content of the answers to the substance of the questions.	The student presents the program material deeply, meaningfully, in full at a high scientific level; answers all questions and additional questions with full completeness and without errors.

Conduct Policy: (lateness, absence, behavior in the auditorium, late submission of work).

- Punctuality and completion of tasks.
- Mandatory attendance of classes.
- Attending class in a clean medical uniform.
- Eliminating conversations on a cell phone in the classroom.
- Active participation in the learning process.
- Doing homework on time.
- Academic detention at the time specified by the teacher.

For violations of the Conduct Policy, the total points for discipline might be reduced to 1-10 points.

Academic Ethics Policy.

- Be tolerant, respect the opinions of others.
- Formulate objections in the correct form.
- Constructively support feedback in all classes.
- Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the following: the absence of references when using printed and electronic materials, quotes, thoughts and works of other authors or students.
- Prompting and cheating during tests, exams, classes is unacceptable as well as passing an exam for another student, unauthorized copying of materials.

For violations of the Academic Ethics Policy, the total points for the discipline may be reduced to 1-10 points.

Guidelines for the lessons of the discipline

Key questions covered in lesson 1.

1. What experiments demonstrated the hereditary role of DNA?
2. Who discovered the infectious agent of pneumonia?
3. How did Griffith identify types of strains of streptococcus?
4. What experiments do scientists name *in vitro*?
5. What experiments do scientists name *in vivo*?
6. Compare the pictures explained in teacher's presentation with given poster.

Find differerences between them.

7. Why is it important to sign type of strain?

Recommended reading for the lesson:

1. Biology. Campbell.11th revised edition, 2016.
2. Biology. Sylvia S. Mader. 1998. P.222-224.
3. https://www.sciencedirect.com/science/article/abs/pii/B9780128028230000018
4. https://www.sciencedirect.com/science/article/abs/pii/B9780128020746000035

Key questions covered in lesson 2.

1. How many variants of nucleotide changes do you know?
2. Give an example of DNA mistake that may occur in the gen that are known in literature.
3. Demonstrate the variant of missense mutation realization.
4. What is the reason of frameshift mutation?
5. How can be nonsense mutation found?
6. Read Beadle and Tatum experiment with Neurospora. Construct the methabolic way of arginine synthesis.
7. In teacher's example test includes minimal and complete media growth experiments as "controls": what do these experiments "control" for?
8. Supposing growth occurred on both minimal and complete medium, what would you conclude?

Recommended reading for the lesson:

1. Biology. Campbell.11th revised edition, 2016
2. Biology. Sylvia S. Mader. 1998. P.235-250
3. https://www.sciencedirect.com/science/article/abs/pii/B9780128028230000031
4. https://www.khanacademy.org/science/biology

Key questions covered in lesson 3.

1. How many types of chromosomal staining are existed?
2. How many generations of karyotyping are progressed in biology?
3. For analysis what parts of chromosome does Ag used?
4. Describe the advantages of FISH technique in diagnosis of hereditary deseases.
5. Find type of defect under microscope.

Recommended reading for the lesson:

1. Biology. Sylvia S. Mader. 1998. P.278-284.
2. Lyon J., Gorner P. 1995. Altered fates: Gene therapy and the retooling of human life. New York.

Key questions covered in lesson 4

1. What is the main principle of Sanger sequencing?
2. What length fragment may be analysed by Southern blot?
3. For what purposes doctor may use Southern blot method?
4. Solving of tasks.

Recommended reading for the lesson:

1. https://letstalkscience.ca/educational-resources/backgrounders/sanger-sequencing#
2. https://www.sigmaaldrich.com/KG/en/technical-documents/protocol/genomics/sequencing/sanger-sequencing
3. Biology. Campbell. 2016.

Key questions covered in lesson 5.

1. What is the main principle of PCR activity?
2. Where does PCR used?
3. How many reagents are necessary for reaction?
4. Give an examples of PCR application in medicine.

Recommended reading for the lesson:

1. https://www.ncbi.nlm.nih.gov/books/NBK481559/
2. https://www.bcm.edu/departments/molecular-virology-and-microbiology/research/human-microbiome-project

Methodological instructions for the implementation of independent work on the discipline

1. Read Meselson and Stahl experiment.
   Hershey and Chase experiment.
   Explain the reasons of particular radionuclides application.

2. Read material about DNA structure, use indexes of DNA molecule.
   Solve problems in written form.

3. Training on site https://biomolecules.app/
4. Passing the game on site https://labsimulator.net