

# INTERNATIONAL HIGHER SCHOOL OF MEDICINE

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APPROVED

Chairman of academic and methodical council,  
Vice-Rector for Academic and Clinical affairs

\_\_\_\_\_ A.A.Usenova

« \_\_\_\_\_ » \_\_\_\_\_ 20\_\_ y.

## WORKING PROGRAM in GENETICS AND ECOLOGY OF HEALTH for master's program in the field of Public Health

Common work content: 4 credits (60 hours)  
Auditorium block: 32 hr.  
Self-work of student: 28 hr.  
Semester: 1  
Final control: passed  
Program is designed: Ph.D. ass.prof. Ch. S. Ismailova  
G. Berbolot kyzy

### The amount of required academic knowledge that a master's student must acquire

In accordance with the MVSM curriculum, the discipline is taught in the following scope:

Semester	Credits	Lectures	Practical lessons	Seminar lessons	Unit control	Independent work	Total
1	2	8	8	12	4	28	60
<b>Total</b>	2	8	8	12	4	28	60

It considered at faculty meeting the department of Natural Sciences

Protocol No.\_\_\_\_ dated “\_\_” \_\_\_\_\_ 202\_\_y

Head of Department \_\_\_\_\_ Ch.S. Ismailova

Reviewed and Approved at the meeting of Cyclic Methodical Commission

Protocol No.\_\_\_\_ dated “\_\_\_\_\_” \_\_\_\_\_ 202\_\_

Cyclic Methodical Commission Chairman \_\_\_\_\_ A.E. Bazhanova

Bishkek



**Program authors:** acting Assoc. Prof., PhD in Biology Ch.S. Ismailova,  
teacher G. Berbolot kyzy

**Reviewers:** PhD, Associate Professor, Head of the Department of  
Public Health, IHSM, K.O. Dzhusupov

## **2. Approval of the WPD for execution in the next academic year**

Chairman of the EMS

\_\_ \_\_\_\_\_ 20\_\_ y.

The work program was reviewed, discussed and approved for implementation in the 2025-2026 academic year at a meeting of the department.

Protocol from \_\_ \_\_\_\_\_ 20\_\_ y. № \_\_ Head of the department

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### **3. Planned learning outcomes in the discipline**

#### **3.1 Objectives of the discipline development**

- To provide students with a holistic understanding of the relationship between genetic mechanisms and the influence of environmental factors on human health.
- To teach understanding of the role of unfavorable environmental factors in the development, manifestation and course of genetic diseases.
- Prepare students to use the principles of ecogenetics in medical practice, prevention and health protection.

#### **The objectives of the discipline are:**

- To familiarize students with the basics of medical genetics and environmental medicine.
- To consider the molecular mechanisms of interaction between the genotype and environmental factors (mutagens, carcinogens, radiation, toxins, nutrition).
  - To study the effect of environmental stressors on gene expression, epigenetic processes, and hereditary diseases.
- Analyze examples of ecological and genetic diseases (cancer, congenital malformations, neurodegenerative diseases, etc.).
- Develop skills to assess the risk of environmental factors at the population and individual levels.
- To teach how to use modern methods of diagnosis, monitoring and prevention of ecological and genetic disorders.
- To develop students' ability to critically analyze scientific literature and data from international organizations (WHO, UNEP, FAO, etc.).

#### **3.2 The place of discipline in the structure of the educational program**

##### **3.2.1 Prerequisites:**

- Anatomy
- Pathophysiology
- Therapy
- Medical Biology
- Molecular Biology

##### **3.2.2 Postrequisites:**

- Public health and wellness
- Clinical disciplines

#### **Competencies that are formed during the study of the discipline**

**PC-2** – is able to carry out educational, educational and promotional activities among the population aimed at preventing the most common diseases, forming a healthy lifestyle, preserving and strengthening public health.

**To know:** Factors adversely affecting the health of the population. Causes and conditions of occurrence and development of the most common diseases.

**Be able to:** Identify the adverse factors contributing to the deterioration and development of human disease.

**Possess:** Planning skills for measures to eliminate the adverse effects of harmful factors and conditions.

**PC-4** - is capable and ready to carry out anti-epidemic measures, protect the population in the foci of particularly dangerous infections, in case of deterioration of the radiation situation and natural disasters, and other emergency situations.

**To know:** epidemiology of especially dangerous infections, deterioration of the radiation situation and natural disasters

**Be able to:** apply a set of appropriate sanitary and anti-epidemic measures in case of particularly dangerous infections, deterioration of the radiation situation and natural disasters

**Possess:** skills of working with regulatory legal acts in case of particularly dangerous infections, deterioration of the radiation situation and natural disasters

**The amount of required academic knowledge that a student must acquire**

In accordance with the MVSH curriculum, the discipline is taught in the following scope:

	Number of	Lectures	Practical seminar sessions	Independent work	Total hours
Semester	Number of credits	Lectures	Practical and seminar classes	Independent work	Total hours
1	2	8	24	28 ч.	60 ч.
<b>TOTAL</b>	<b>2</b>	<b>8</b>	<b>24</b>	<b>28 ч.</b>	<b>60 ч.</b>

**Scope, content of the course and types of academic work**

№	Unit Theme	Overall labor intensity	Classroom work				Extracurricular activities		
			Lectures	Practical lessons	Handing over unit	TOTAL	Tasks to complete	Working with literature	TOTAL
1.	Environmental factors and their role in the occurrence of genetic disorders	30	4	10	2	16	7	7	14
2.	Environmental factors and the course of hereditary diseases	30	4	10	2	16	7	7	14
	<b>TOTAL</b>	<b>60</b>	<b>8</b>	<b>20</b>	<b>4</b>	<b>32</b>	<b>14</b>	<b>14</b>	<b>28</b>

**The structure and content of the discipline.**

**UNIT №1**

The total volume - 30 h

Lectures - 4 hours

Practical Classes - 10 h

Unit Completion - 2 h

Independent Work - 14 h

Duration: 30 h

Classroom hours	16 h
Extracurricular work of students	14 h

### Thematic lecture plan

№	Topic of the lecture	Number of hours
1.	Mutagenic environmental factors. <ul style="list-style-type: none"> <li>• The concept of mutagens and genotoxins.</li> <li>• Ionizing radiation and its effects on DNA.</li> <li>• Chemical mutagens: benzene, pesticides, heavy metals.</li> <li>• Biological mutagens (viruses).</li> <li>• Examples: Chernobyl, Semipalatinsk, industrial zones.</li> </ul>	2
2.	Mechanisms of the genotoxic effect of pollutants. <ul style="list-style-type: none"> <li>• DNA damage (breaks, deletions, point mutations).</li> <li>• Violations of DNA repair.</li> <li>• Chromosomal aberrations and genome instability.</li> <li>• The role of mutagens in hereditary diseases and congenital malformations.</li> </ul>	2
	TOTAL:	4

### Thematic plan for practical classes

№	The topic of the seminar (practical) lesson	hours
1.	<b>Practical lesson 1.</b> Analysis of the effect of radiation on genetic stability. <ul style="list-style-type: none"> <li>• Work with radiation background maps.</li> <li>• Comparison of data on regions with increased radiation exposure.</li> <li>• Mini-task: to identify the relationship between radiation and congenital pathologies.</li> </ul>	2
2.	<b>Practical lesson 2.</b> Effects of industrial toxins on the health of offspring. <ul style="list-style-type: none"> <li>• Case study: chemical production and the growth of genetic abnormalities.</li> <li>• Analysis of medical statistics.</li> <li>• Collective discussion of preventive measures.</li> </ul>	2
3.	<b>Seminar 1.</b> Chemical mutagens and their role in genetic pathology. <ul style="list-style-type: none"> <li>• Discussion of articles about benzene, lead, mercury.</li> <li>• Discussion: What are the most dangerous chemical factors?</li> </ul>	2
4.	<b>Seminar 2.</b> Ecology and congenital malformations. <ul style="list-style-type: none"> <li>• Analysis of publications on the relationship between pollution and congenital anomalies.</li> <li>• Mini-reports of students.</li> </ul>	2
5.	<b>Seminar 3.</b> Environmental disasters and genetics. <ul style="list-style-type: none"> <li>• Chernobyl, Fukushima, Armyansk.</li> <li>• Discussion: "Is it possible to prevent the growth of genetic diseases after disasters"</li> </ul>	2
6.	Unit control. A 30-question test	2
	TOTAL:	12

#### Independent work (14 hours)

The master's student performs one assignment to choose from.

- Preparation of the abstract "The influence of genetic predisposition on the development of chronic diseases".
- Genetic testing: ethical, legal and social aspects.
- Environmental factors and their role in the occurrence of genetic disorders.
- Gene mutations caused by environmental pollution: health consequences.
- Preparation of a presentation on the topic "Personalized medicine: how genetics is changing the approach to treatment and prevention."

### Examples of situational tasks

#### Unit 1. Environmental factors and their role in the occurrence of genetic disorders

##### Task 1.1

**Situation:** An increase in the number of congenital malformations in newborns has been registered in an industrial city. Epidemiological studies have shown high concentrations of heavy metals (lead and cadmium) in soil and water.

##### Questions for discussion:

1. What are the mechanisms of action of heavy metals on the human genetic apparatus?
2. What biomonitoring methods can be used to identify the mutagenic effect?
3. How can the impact of these factors on the population be minimized?

##### Task 1.2

**Situation:** After the accident at the radioactive waste storage facility, there was an increase in the incidence of cancer and spontaneous abortions among the population living within a 10 km radius.

##### Questions for discussion:

1. What is the role of radiation in the development of genetic disorders?
2. Which groups of diseases are most likely to be associated with radiation exposure?
3. What preventive and control measures should be taken in this situation?

### Test tasks

#### Unit 1. Environmental factors and their role in the occurrence of genetic disorders

1. Which of the listed factors relates to physical mutagens?
  - A) Benzene
  - B) Ultraviolet radiation
  - C) Aflatoxin
  - (D) Organochlorine pesticides
  - E) Nicotine

**The correct answer is: B**

2. Which cell structure is most vulnerable to the action of mutagenic factors?
  - A) Membrane
  - B) Cytoplasm
  - C) DNA
  - D) Ribosomes
  - E) Lysosomes

**The correct answer is: C**

3. Chemical mutagens include:
  - A) X-rays
  - B) Formaldehyde

- C) Radon
- D) Infrared radiation
- E) Gamma radiation

**The correct answer is: B**

4. What effect can radiation have on germ cells?
- A) Decreased immunity
  - B) Genetic mutations in offspring
  - C) Weight gain
  - D) Acceleration of metabolism
  - E) Violation of pressure regulation

**The correct answer is: B**

5. The term "genotoxicity" means:
- A) Damage to the cell membrane
  - B) Modification of the genetic material
  - C) Increased frequency of infections
  - D) Decreased enzymatic activity
  - E) Damage to protein structures

**The correct answer is: B**

6. Which metal has a pronounced mutagenic effect?
- A) Sodium
  - B) Calcium
  - C) Lead
  - D) Magnesium
  - E) Potassium

**The correct answer is: C**

7. Which method is most often used to evaluate the mutagenic effect of chemicals?
- A) Skin tests
  - B) The Ames microbiological test
  - C) Electrocardiography
  - D) Ultrasound
  - E) Radiography

**The correct answer is: B**

8. Which method is most often used to evaluate the mutagenic effect of chemicals?
- A) Skin tests
  - B) The Ames microbiological test
  - C) Electrocardiography
  - D) Ultrasound
  - E) Radiography

**The correct answer is: B**

9. What type of mutation is most often induced by ionizing radiation?
- A) Translocations
  - B) Triplet extensions
  - C) Long repeat insertions

- D) Deletions and chromosomal aberrations
- E) Epigenetic labels

**The correct answer is: D**

10. Which of the statements is true about environmental disasters and genetic pathology?

- A) They do not affect the level of hereditary diseases
- B) They contribute to the growth of mutagenic load
- C) They improve genetic stability
- D) They reduce the mutation rate
- E) They increase resistance to radiation

**The correct answer is: B**

### **The structure and content of the discipline.**

#### **UNIT №2**

The total volume - 30 h

Lectures - 4 hours

Practical Classes - 10 h

Unit Completion - 2 h

Independent Work - 14 h

Duration: 30 h

Classroom hours	16 h
Extracurricular work of students	14 h

#### **Thematic lecture plan**

№	Topic of the lecture	Number of hours
1.	<p><b>Lecture 3. Ecology and monogenic diseases</b></p> <ul style="list-style-type: none"> <li>• Examples of diseases: cystic fibrosis, phenylketonuria, sickle cell anemia.</li> <li>• The influence of pollutants on the course and prognosis.</li> <li>• The interaction of the genotype and the environment (gene–environment interaction).</li> <li>• Clinical observations.</li> </ul>	2
2.	<p><b>Lecture 4. Epigenetics and the environment</b></p> <ul style="list-style-type: none"> <li>• The main mechanisms of epigenetics: DNA methylation, histone modification, and microRNAs.</li> <li>• Environmental factors that cause epigenetic changes (toxins, nutrition, stress).</li> <li>• Epigenetic regulation in hereditary diseases.</li> <li>• Prospects of epigenetic therapy.</li> </ul>	2
	<b>TOTAL:</b>	4

## Thematic plan for practical classes

№	The topic of the seminar (practical) lesson	hours
1.	<b>Practical lesson 4. Parkinson's disease and ecology</b> <ul style="list-style-type: none"> <li>• Clinical review: the role of pesticides and heavy metals.</li> <li>• Working in small groups: building a pathogenetic scheme.</li> <li>• Development of recommendations for risk reduction.</li> </ul>	2
2.	<b>Practical lesson 5. The influence of diet and nitrates on the manifestations of genetic diseases</b> <ul style="list-style-type: none"> <li>• Task: analysis of food products with high nitrate content.</li> <li>• Case study: phenylketonuria and nutrition.</li> <li>• Discussion of the role of diet in correcting genetic diseases.</li> </ul>	2
3.	<b>Seminar 4. Hereditary cardiovascular diseases and ecology</b> <ul style="list-style-type: none"> <li>• The role of air pollutants in the development of hypertension and cardiomyopathy.</li> <li>• Analysis of clinical cases.</li> </ul>	2
4.	<b>Seminar 5. Эпигенетические механизмы патологии</b> <ul style="list-style-type: none"> <li>• Схемы эпигенетической регуляции.</li> <li>• Обсуждение новых исследований.</li> </ul>	2
5.	<b>Seminar 6. Prevention of genetic diseases through environmental measures.</b> <ul style="list-style-type: none"> <li>• Comparison of international programs.</li> <li>• Final discussion: "What measures can we really implement?"</li> </ul>	2
6.	<b>Unit control.</b> 30-question test.	2
	<b>TOTAL:</b>	12

### Independent work (14 hours)

The master's student performs one assignment to choose from.

- Preparation of the essay "The role of epigenetics in adaptation to adverse environmental conditions".
- Environmental triggers of exacerbation of bronchial asthma with hereditary predisposition
- Smoking, air pollution, and the course of cystic fibrosis in patients with the CFTR genetic mutation
- Preparation of the report "The influence of nutrition and microbiota on the course of hereditary autoimmune diseases (Crohn's disease, celiac disease, SLE)"
- Psychoemotional stress and an unfavorable social environment as factors of manifestation of hereditary mental diseases (schizophrenia, bipolar disorder)

### Examples of situational tasks

#### Unit 2. Environmental factors and the course of hereditary diseases

##### Task 2.1

**Situation:** A patient with phenylketonuria who followed a diet in childhood has a worsening condition in adulthood due to living in an industrial area with high levels of pesticides and nitrates in the water.

#### Questions for discussion:

1. How can ecotoxins affect the course of phenylketonuria?
2. What mechanisms of interaction between a genetic defect and environmental factors can enhance the manifestations of the disease?

3. What measures are possible to correct the patient's condition?

### **Task 2.2**

**Situation:** A young woman with a hereditary predisposition to Parkinson's disease (a mutation in the LRRK2 gene) lives in a rural area where pesticides are widely used. At the age of 35, she developed her first neurological symptoms.

#### **Questions for discussion:**

1. What role did environmental factors play in the manifestation of the disease?
2. Why exactly can pesticides accelerate the development of neurodegenerative disease?
3. What preventive measures can be offered in such cases?

### **Test tasks**

#### **Unit 2. Environmental factors and the course of hereditary diseases**

1. Which environmental factor is most often associated with the manifestation of Parkinson's disease?

- A) Ascorbic acid
- (B) Pesticides
- C) Vitamin D
- D) Iodine
- E) Sodium chloride

**The correct answer is: B**

2. Which hereditary disease is most often aggravated by exposure to nitrates and pesticides?

- A) Type I diabetes mellitus
- B) Phenylketonuria
- C) Thalassemia
- D) Hemophilia
- E) Down syndrome

**The correct answer is B**

3. What is the basis of epigenetic changes under the influence of environmental factors?

- A) Change of nucleotides
- B) Chromosome duplication
- C) DNA methylation and histone modification
- D) Membrane restructuring
- E) Synthesis of new proteins

**The correct answer is: C**

4. In patients with cystic fibrosis, polluted air leads to:

- A) Complete remission of the disease
- B) Reducing the frequency of infections
- C) Deterioration of lung function
- D) Increased enzymatic activity
- E) The cure

**The correct answer is: C**

5. What role do pesticides play in the development of neurodegenerative diseases?

- A) They have neuroprotective effects
- B) They accelerate the death of neurons
- C) They reduce the mutation rate
- D) They improve the metabolism of neurotransmitters

E) They stimulate the growth of nervous tissue

**The correct answer is: B**

6. What disease is associated with a violation of epigenetic regulation induced by environmental factors?

A) Angelman syndrome

B) Huntington's disease

C) Oncological diseases

D) Hemophilia

E) Turner syndrome

**The correct answer is: C**

7. Why are patients with genetic diseases more likely to suffer from exposure to polluted environments?

A) Due to increased physical activity

B) Due to the presence of genetic defects that reduce adaptation

C) Due to a better metabolism

D) Due to the absence of mutations

E) Due to an increased level of immunity

**The correct answer is: B**

8. What does the term "gene–environment interaction" reflect?

A) The independent action of genes and environmental factors

B) Strengthening or weakening of the manifestation of the disease under the influence of ecology

C) Lack of relationship between genes and environment

D) Complete exclusion of hereditary factors

E) Only the positive influence of the environment

**The correct answer is B**

9. What factor can modify the course of cardiovascular hereditary diseases?

A) Reduced salt intake

B) Air pollution

C) Physical activity

D) Rational nutrition

E) Taking vitamins

**The correct answer is: B**

10. Which approach is most effective for preventing exacerbations of genetic diseases in conditions of unfavorable ecology?

A) Ignoring environmental factors

B) Monitoring and minimization of environmental risks

C) Withdrawal of all medications

D) Increased physical activity

(E) Increased exposure to pollutants

**The correct answer is: B**

#### **Control over the study of the discipline.**

The assessment of the assimilation of the material by undergraduates is carried out through testing at the border control. The score for a unit is the sum of the test scores (maximum 60) and for independent

work (maximum 40). In total, a master's student can receive a maximum of 100 points per unit. The final score for the discipline is displayed as the average of the two units. The credit is awarded based on the results of the interview at the end of the discipline. A master's student is allowed to take credit if the final score exceeds 59.

### The system of assessment of academic achievements of a graduate student

Criteria for grading a discipline				
Maximum score	Intervals			
	«unsatisfactory»	«satisfactory»	«good»	«excellent»
<b>Midterm control – testing - 60</b>	0-59	60-74	75-89	90-100
Interval criteria	The proportion of correct answers is less than 60% of the total	The proportion of correct answers ranges from 60% to 74%.	The proportion of correct answers ranges from 75% to 89%	The proportion of correct answers ranges from 90% to 100%
<b>Independent work - 40</b>	0-23	24-30	31-35	36-40
Interval criteria	When completing the assignment, it is clear that the graduate 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; lacks the necessary theoretical knowledge and the ability to apply them to solve practical problems. It is also marked "unsatisfactory" if the undergraduate student refuses to complete the assignment on the IWS.	When completing the assignment, it is clear that the graduate student has mastered only the basic program material, but does not know individual features and details; makes inaccuracies; violates the sequence in the presentation of the program material; the material is not systematized, incorrectly formulated; the speech is mostly literate, but poor; possesses a minimum sufficient level of competence; solves professional practical tasks with errors, in particular basically justifies the decisions made.	When completing the assignment, the master's student demonstrates the formation of competencies, has a sufficient level of professional terminology; correctly, logically and essentially states the answer, does not allow significant errors and inaccuracies in answering questions, the presentation is sufficiently systematic and consistent; when solving a practical problem, he justifies the decisions made correctly.	When completing the assignment, it is clear that the graduate student demonstrates 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 difficulty answering when changing assignments; knows how to solve professional problems. practical tasks; justifies the decisions correctly, is able to

				independently summarize and present the material.
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## 5. List of recommended literature

### Basic Literature :

#### Basic textbooks on molecular biology and genetics.

1. Lodish H., Berk A., Kaiser C.A., Krieger M., Scott M.P., Bretscher A., Ploegh H., Matsudaira P. *Molecular Cell Biology*. 9th ed. New York: W. H. Freeman, 2021.
2. Pierce B. A. *Genetics: A Conceptual Approach*. 7th ed. New York: Macmillan Learning, 2023.
3. Strachan T., Goodship J., Chinnery P. *Human Molecular Genetics*. 5th ed. New York: Garland Science, 2021.
4. Griffiths A.J.F., Wessler S.R., Carroll S.B., Doebley J. *Introduction to Genetic Analysis*. 12th ed. Macmillan Learning, 2020.
5. Alberts B. Et al. *Molecular Biology of the Cell*. 7th ed. New York: Garland Science, 2022.

#### Books on ecology and toxicology. Environmental & Medical Genetics

6. Jirtle R.L., Skinner M.K. *Environmental Epigenomics in Health and Disease*. Springer, 2019.
7. Suk W.A., Olden K. *The Environment and Human Health: The Role of Environmental Hazard in Human Disease*. Springer, 2020.
8. Ladeira C., Viegas S. *Human Biomonitoring: New Insights into the Exposure to Emerging Pollutants*. Springer, 2019.
9. Costa L.G., Aschner M., Gupta R.C. (eds.) *Influence of Environmental Factors on the Human Health*. Academic Press, 2017.
10. Melnick R.L., Lucier G. *Environmental Toxicants: Human Exposures and Their Health Effects*. Wiley, 2019.

#### Specialized Literature (Genetics & Ecology)

1. Lee S.H., Park J.H., Kim Y. *Gene–Environment Interactions in Complex Diseases*. Academic Press, 2021.
2. Gallo R.C., Wong-Staal F. *Genetic and Environmental Factors in Human Disease*. Oxford University Press, 2018.
3. Liroy P.J., Weisel C.P. *Exposure Science: Basic Principles and Applications*. Academic Press, 2018.
4. Wolffe A.P., Matzke M.A. *Epigenetics: Regulation, Development, and Disease*. Springer, 2020.
5. Li E., Zhang Y. *DNA Methylation, Epigenetics and Human Disease*. Springer, 2018.

#### Review Articles (for seminars and research work)

##### Modern research on epigenetics and the influence of the environment on the genome.

1. Baccarelli A., Bollati V. “Epigenetics and environmental chemicals.” *Annual Review of Public Health*. 2009; 30: 103–122.
2. Hou L., Zhang X., Wang D., Baccarelli A. “Environmental chemical exposures and human epigenetics.” *International Journal of Epidemiology*. 2012; 41(1): 79–105.
3. Herceg Z., Lambert M.P. et al. “Towards incorporating epigenetic mechanisms into carcinogen identification and evaluation.” *Carcinogenesis*. 2013; 34(9): 1955–1967.

4. Feil R., Fraga M.F. “Epigenetics and the environment: emerging patterns and implications.” *Nature Reviews Genetics*. 2012; 13: 97–109.
5. Landrigan P.J., Fuller R. “Pollution, Health and the Planet: Time for Decisive Action.” *Lancet Planetary Health*. 2018; 2(9): e355–e356.