EPIGENETICS

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
6	216	Exam

Students will know the role of differential gene expression in the implementation of the development program of multicellular organisms, the molecular and cellular bases of heredity, the levels of organization of chromatin fibrils, the concept of "histone code", have an idea of genomic imprinting in placental mammals; they will be able to determine the molecular mechanisms of chromatin remodeling, determine inherited changes in the spatial conformation of proteins with phenotypic features; they will have the skills of histone modification, chromatin remodeling, regulation of gene expression at the level of the nucleotide sequence.

Course structure:

1. INTRODUCTION TO EPIGENETICS
   - 1.1. The history of the discovery of epigenetic mechanisms of inheritance.
   - 1.2. The role of differential gene expression in the implementation of the development program of multicellular organisms, the determination of fate at the level of cells and tissues during the early stages of development.
   - 1.3. Conrad Waddington's Theory of the Epigenetic Landscape.

2. MECHANISMS OF EPIGENETIC INHERITANCE
   - 2.1. Molecular and cellular bases of heredity.
   - 2.2. Modern ideas about the organization of the genome.
   - 2.3. Mechanisms of determination of early development and regulation of gene expression at the level of the nucleotide sequence, epigenetic modifications of DNA and histones, chromatin organization, transcription regulation and post-transcription level.
   - 2.4. Mechanisms of inheritance of epigenetic information at different levels and the possibility of changing it.

3. STRUCTURAL AND FUNCTIONAL ORGANIZATION OF EUKARYOTIC CHROMATIN
   - 3.1. Levels of organization of chromatin fibrils.
   - 3.2. Modifications and variants of histones as markers of active genes.
   - 3.3. Histone code.
   - 3.4. Features of the packaging of euchromatin and heterochromatin, the organization of the functional elements of the chromosome.
   - 3.5. Spatial organization of chromatin in the nucleus.
   - 3.6. Molecular mechanisms of chromatin remodeling and their implementation during development.

4. EPIGENETIC REGULATION INVOLVING DIFFERENT TYPES OF NON-CODING RNAS

4.1. Concepts of non-coding RNAs as regulatory molecules.

4.2. Participation of non-coding RNAs in the transcription complex, as part of spliceosomes, in the implementation of translation processes.

4.3. Small interfering RNAs and microRNAs in cell protection, regulation of gene expression, chromatin remodeling during gatemogenesis and early development, as well as silencing.

4.4. The role of long non-coding RNAs in the compartmentalization of the nucleus, the regulation of biogenesis of various components of the nucleus and cell, as well as the regulation of chromatin activity, including during the inactivation of the X chromosome in female mammals.

5. MECHANISMS OF PROTEIN INHERITANCE

5.1. Expanding the framework of the central dogma of molecular biology with the inclusion of heredity based on protein molecules.

5.2. Mechanisms for maintaining positive feedback involving the self-activation of enzymes.

5.3. Inherited changes in the spatial conformation of proteins with phenotypic features.

5.4. The role of protein heredity in the formation of molecular mechanisms of memory and the development of pathogenic amyloidosis.

6. APPLIED ASPECTS OF EPIGENETICS

6.1. The idea of genomic imprinting in placental mammals.

6.2. Epigenetic disorders and related human diseases.

6.3. The role of epigenetic changes in aging and the development of human diseases.

6.4. Development of research aimed at reprogramming mammalian somatic cells into pluripotent ones for solving problems of regenerative medicine and creating artificial gametes.

6.5. The possibilities of using genetic approaches for the development of personalized medicine.