**Course Program of «Genes & Genomes»**

**Staff Members Responsible for the course:** Prof., Dr. Shkurat Tatiana Pavlovna, Genetics department of Southern Federal University; Associate Prof. Dr. Butenko Elena Viktorovna Genetics department of Southern Federal University.

1. **The name of the educational program in which the discipline is read.**

The discipline "Genes & Genomes” is read in the framework of the Master's program "Human ecology with fundamentals of biomedicine" in the direction of training 06.04.01 "Biology", graduate level.

**2. The overall complexity**

The total complexity of the discipline is 5 credit units, 180 hours. The program of the discipline provides:

Second semester: 18 lectures, 36 laboratory practice, 99 student independent work, 5 credit units

**3. The place of discipline in the structure of the educational program.**

The discipline "Genes& Genomes" refers to the basic module and is one of the disciplines of master's programs "Human ecology with fundamentals of biomedicine", "Genetics". Students are engaged in this discipline in semester 1.

It relies on the courses “Microbiology”, “Biochemistry”, “Genetics”, “Immunology” and

"Virology" and provides the skills necessary for a specialist for professional activities.

**4. The purpose of studying the discipline.**

Formation of a student's competences related to the use of modern methods for studying gene functions, gene mapping, genome sequencing, data analysis, molecular phylogeny of the presentation and publication of biological information. In this course we will study the information obtained as a result of genome projects and combine this information with the knowledge gained in the pre-genomic era of molecular biology. If the goal of student learning is to prepare students for a future career, then they need to be taught genomes!

**5. Requirements for the results of mastering the discipline**

In accordance with the federal state educational standard of higher education in the direction of training 06.04.01 Biology (master’s degree level) discipline "Genes& Genomes"

is aimed at the formation of the following competencies:

**General professional competence -**

readiness to use fundamental biological ideas in the field of professional activity for setting and solving new problems

the ability to independently analyze available information, identify fundamental problems, set a task and carry out field and laboratory biological research in solving specific problems using modern equipment and computing tools, be responsible for the quality of work and scientific accuracy of the results

A graduate of the master program should be willing to creatively apply modern computer technology in the collection, storage, processing, analysis and transmission of biological information to solve professional problems.

A graduate from a master’s degree program must have the ability to creatively to use knowledge in scientific and production technology fundamental and applied sections of disciplines (modules) defining orientation (profile) of the Master's program ;

A graduate from a master’s degree program must have the ability to generate new ideas and methodical solutions

As a result of mastering the discipline, the student should:

**Know:**

* The structure of a polynucleotide and the chemical differences between DNA and RNA
* How chromatin structure influences genome expression
* The various types of chemical modification that can be made to histone proteins, and link this information to the concept of the ‘histone code’
* How DNA methylation is carried out and describe the importance of methylation in silencing the genome
* The details of the involvement of DNA methylation in genomic imprinting and X inactivation
* The key features of automated DNA sequencing and evaluate the importance of automated sequencing in genomics research
* The content of the human nuclear genome
* The structure and organization of the human mitochondrial genome
* The Application of the Human Genome Project
* The major differences between the genetic organizations of the genomes of humans, plants, insects, yeast and bacteria
* The physical features and gene contents of mitochondrial and chloroplast genomes
* The modern interpretation of the genome expression pathway, indicating the main points at which genome expression is regulated
* Understand the principles coding and non-coding RNA
* Understand the principles how transcriptomes are studied
* How the transcriptome and proteome are studied
* The meaning of each codon in the genetic code
* The strengths and weaknesses of the various methods used to construct physical maps of genomes
* The methods used to inactivate individual genes in yeast and mammals, and how inactivation can lead to identification of the function of a gene
* The various experimental methods used to identify parts of a genome sequence that specify RNA molecules
* How radiation hybrids and clone libraries are used in STS mapping radiation hybrids and clone libraries are used in STS mapping
* Have an understanding of modern methods of analyzing gene expression.
* The mechanisms for the preservation of information by living systems and the implementation of programs embedded in the genomes, in ontogenesis, during differentiation and in the process of functioning of living systems
* Understand the principles of phylogenetic analysis.
* The potential and achievements of comparative genomics as a means of understanding a genome sequence

**Be able to:**

* access the genomes.
* Professionally use GenBank and UCSC Genome Browser;
* Aanalyze genome sequences in Genomes.
* Apply the obtained theoretical knowledge in practice;
* Вuild and analyze phylogenetic trees;
* Be able to create a contig clone in various ways;
* Perform functional annotation of gene expression analysis data;
* Formulate conclusions based on discussion of ethical, legal and social issues raised by Human Genome Projects

**Have skills to:**

\* Use shotgun techniques to sequence a small bacterial genome

\* Use link analysis techniques to build genetic maps that provide detailed information about how analysis is performed in different body types, including humans and bacteria

\* Analyse the genome sequences, genetic experiments and processing of their results.

\* Work independently with web-resources on bioinformatics.

\* Use routine and modern methods of genome analysis

\* Descript methods that can be used to obtain more detailed information about the activity of a protein encoded by an unknown gene

\* The use of in situ fluorescent hybridization (FISH) techniques used to construct a physical map, including modifications used to increase the sensitivity of this technique

\* Use methods to search for key features of a phylogenetic tree and distinguish between inferred trees, true trees, gene trees and species trees graphic and video information

\* Use molecular phylogenetic methods to study the origins of modern humans and the migrations of modern humans to Europe and New World.

**6. The contents of the discipline**

The content of the discipline "Cenes & Genomes" is built on a modular principle, with four main modules:

**Module 1. GENES**

Structural organization of pro and eukaryotic genes

Topic 2. DNA, Genes, Chromosomes

Topic 3. Genetic maps

Topic 4. Mapping Genes Methods

Topic 5. Methods for studying gene functions

**Module 2. GENOME ANATOMIES.**

Topic 1. Genomes, Transcriptomes and Proteomes

Topic 2. Accessing the Genome.

Topic 3. Genome Sequence.

Topic 4. The Anatomy of the Prokaryotic & Eukaryotic Genomes

Topic 5. The Human Genome. The Application of the Human Genome Project

Topic 6. Non Coding Genome

**Module 3. HOW GENOMES FUNCTION**

Topic 1. Regulation of Genome Activity.

Topic 2. Chromatin Modifications and Genome Expression

Topic 3.  [Assembly of the Transcription Initiation Complex.](https://www.ncbi.nlm.nih.gov/books/NBK21115/)

Topic 4. Synthesis and Processing of RNA

Topic 5. Regulation of Genome Activity During Development

**Module 4. HOW GENOMES EVOLVE**

Topic 1. Non-coding DNA and Genome Evolution

Topic 2. Molecular Phylogenetics

**7. Basic educational technology**

Discipline teaching provides the following forms of organization of the educational process: score-rating system of knowledge assessment during the current control, mid-term control and intermediate certification, interactive lectures, independent student work, testing, project method, presentations.

**8. Forms of control**

The discipline program provides for the following types of control: monitoring progress in the form of a test, a report with a presentation and a project assignment, mid-term monitoring of progress in the form of testing, intermediate control in the form of an exam.

**GRADING SCHEME**

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| --- | --- |
| A | EXCELLENT - outstanding performance with only minor errors |
| B | VERY GOOD - above the average standard but with some errors |
| C | GOOD - generally sound work with a number of notable errors |
| D | SATISFACTORY- fair but with significant shortcomings |
| E | SUFFICIENT - performance meets the minimum criteria |
| FX | FAIL - some more work required before the credit can be awarded |
| F | FAIL - considerable further work is required |