Министерство образования и науки Российской Федерации

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ

“НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ ИТМО”

Р А С П О Р Я Ж Е Н И Е

«13» января 2023 года № 4

О порядке проведения аттестационного испытания

Для осуществления переводов/восстановлений обучающихся ПРИКАЗЫВАЮ:

Утвердить порядок проведения аттестационного испытания в рамках осуществления переводов/восстановлений обучающихся в подразделение Химико-биологический кластер по направлениям подготовки магистратуры 19.04.01 Биотехнология и 06.04.01 Биология.

ПРИЛОЖЕНИЕ. Банк тестовых заданий с критериями оценивания, система перевода показателей академической успеваемости и учебно-научной активности студентов в балльно-рейтинговую систему.

Директор ХБК _____ (подпись) Виноградов В.В. (ФИО)

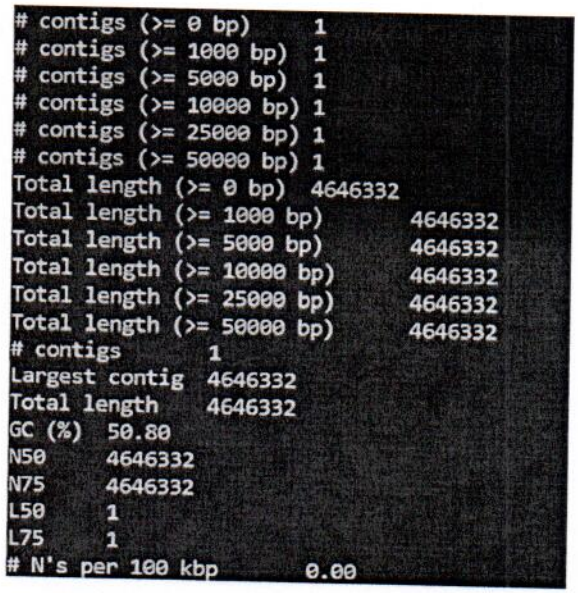
ПРИЛОЖЕНИЕ 1

Приложение к распоряжению от 13.01.2023 № 4

Банк тестовых заданий

по образовательной программе 06.04.01, 19.04.01 «Прикладная геномика / Applied Genomics»

1. Write Unix commands to create a folder, to move it, and delete it.
2. Select is the extension of the file with reads (sequencing data) information?
   a) gff
   b) faa
   c) fastq
   d) gbk
3. What program can be used to filter reads from adapters?
   a) Prokka
   b) TOGA
   c) QUAST
   d) Trimmomatic
4. Which scale is used to record information about nucleotide quality in the read? This scale is used to plot "Per base quality" in the FastQC program.
5. Which of the following parameters are related to the assessment of read quality?
   a) adapter content
   b) GC content
   c) quality of bases (nucleotides) in the sequence
   d) the length of the largest contig
6. Arrange the following sequences in ascending order of length (from minimal to maximum): contig, read, scaffold.
7. Arrange the steps of the genome assembly algorithm. In your answer, write a sequence of letters without commas and spaces (for example: abcde).
   a) scaffold assembly,
   b) quality control of the assembly,
   c) library preparation,
   d) quality control of reads,
   e) assembly of contigs,
   f) sequencing
8. Write at least three metrics for assessing the quality of genome assembly (for instance, from the QUAST report).
9. Do you think this assembly can be considered of high quality? Explain your view point.



10. Name at least one tool to assess the quality of genome assembly.

11. Write a Python command that outputs the string "Hello, World!"

12. What is x after x = 10; x += 1; x = x * 2 (Python)?

13. What types of RNA do you know?

14. How many genes are in the human genome?

    a) 10.000 - 15.000
    b) 20.000 - 25.000
    c) 30.000 - 35.000
    d) 40.000 - 45.000

15. The bat and ball together cost $110. The price of the bat is $100 more than the ball. How much is the ball price?

16. If the chance of getting sick is 20 out of 100, what is the percentage chance of getting sick?

17. What are polyT primers used for? What are polyA primers for?

18. Select the process of RNA synthesis from the DNA matrix?

    a) replication
    b) transcription
    c) translation
    d) duplication

19. Which statement is used to interrupt an infinite loop in Python?

    a) stop
    b) continue
    c) false
    d) break

20. Which of these commands creates the file?

    a) touch file.txt
    b) less file.txt
    c) update file.txt
    d) rm file.txt

21. What happens if a T > AG insertion occurs in the sequence (replacing one nucleotide with two)? How might this affect transcription and data processing?

22. How are unknown nucleotides labeled in the sequence?

a) A
b) T
c) N
d) C

23. Which two parts has the nucleotide fasta file?

a) header and sequence
b) gene name and its length
c) protein sequence and its function
d) start and stop codons

24. Which of the following is not a stop code?

a) UAA
b) UGG
c) UAG
d) UGA

25. Which organelle carries out protein synthesis by the RNA matrix?

26. What is the difference between prokaryotes and eukaryotes?

27. Which area of bioinformatics studies the totality of an organism's genes?

a) Metagenomics
b) Genomics
c) Proteomics
d) Transcriptomics

28. Which instruction is used to declare functions in Python?

a) for
b) def
c) func
d) function

29. Specify the name of the document that describes the rules for writing code in Python.

30. The combination of three consecutive nucleotides in a nucleic acid molecule is called:

a) duplex
b) trypanosoma
c) triplet

31. Expand the parentheses in the expression according to the order in which the expression is evaluated (priority of operations):

a and b or not a and not b

32. Specify the result of the expression "354" + "67" (Python).

33. What is the resulting value of 1 + "ab"?

a) “1ab”
b) 1ab
c) 1“ab”
d) TypeError

34. Which Python function turns a list into a set?

35. Which of the following is not a variable name according to PEP8?

a) 123name
b) my-name
c) my_name

d) my name

Формат проведения: опрос посредством Гугл-формы

Количество вариантов: вариант тестового задания формируется в случайном порядке из банка вопросов

Количество вопросов/заданий в одном варианте: 15

Время выполнения: 45 минут

Система оценивания

Полнота ответа на вопрос/задание	**Количество баллов**
полный правильный ответ	2 балла
частично правильный ответ	1 балл
полностью неверный (или отсутствующий) ответ	0 баллов

Минимальное количество баллов за выполнение варианта тестового задания – 0.

Максимальное количество баллов за выполнение варианта тестового задания – 30.

Студент, набравший 50 % и более баллов (15 и более баллов из 30 возможных), успешно проходит аттестационное испытание.

Студент, набравший менее 50 % баллов (менее 15 баллов из 30 возможных), считается не прошедшим аттестационное испытание и не готовым к освоению образовательной программы.

ПРИЛОЖЕНИЕ 2

Приложение к распоряжению от 13.01.2023 № 4

Банк тестовых заданий

по образовательной программе 19.04.01 «Молекулярная биология и биотехнология / Molecular Biology and Biotechnology»

Part 1 - Molecular biology

1. The central dogma of molecular biology. Semi-conservative DNA replication. Experiments that confirmed semi-conservative DNA replication.

- Definition of the central dogma
- Exceptions of the central dogma
- Relation of a gene and the central dogma
- Definition of transcription and translation
- Role of DNA for data storage
- Role of RNA for information transition
- Role of proteins as effectors
- Schematic description of a replication process
- Experiments of Meselson and Stahl

2. Nucleosides, nucleotides and their examples. Purines and pyrimidines nitrogenous bases. Biological roles of nucleotides in cells.

- Nucleosides and nucleotides: definitions and difference
- Nucleotide composition of DNA and RNA
- Difference of sugars in DNA and RNA
- Difference of the free nucleotides and associated into a string
- Purines and pyrimidines: structure and difference in hydrogen bonds
- Roles of nucleotides in cell

3. The principles of DNA packaging in eukaryotic and prokaryotic cells. The structure of nucleosomes.

- Difference in nucleic acid location in pro and eukaryotic
- Forms of DNA in the cell
- DNA forms and stability, supercoiling
- Histone types, nucleosome structure

- Regulation of expression through the nucleosomes and condensation
- Solenoid structure, chromosomal structure

4. The main types of RNA: structure and functions
   - Main types of RNA and their functions
   - mRNA: production and modification
   - tRNA: structure and basic features
   - rRNA in eukaryotic and prokaryotic organisms
   - Conservative regions of features of RNA: locations and functions
   - microRNA, snRNA, lnRNA, minRNA: types and functions

5. Genetic code. The essence of genetic coding. Basic properties and universality of the genetic code.
   - GenCode definition
   - Triplets in code
   - Degeneration of code
   - Universality of code
   - Polarity of code
   - Non-overlapping of code
   - Unambiguousity of code
   - ORF in code
   - Stop codons
   - Start codon

6. The structure of prokaryotic genes: coding sequence and promoter.
   - Operonic structure of prokaryotic genes, introns in prokaryotes
   - Polycistronic operon structure, role of RBS
   - Promoter-operator relationship, role of promoter
   - Start codon, genetic code modification
   - Enhancers and silencers

7. The mosaic structure of eukaryotic genes (introns and exons), organization of promoters.
   - Exon-intron structure, difference from prokaryotic organisms, alternative splicing, mechanisms of splicing
   - Gene clusters definition

- Transcription factors and its role
- Structural elements of the promoter

8. Replication stages in prokaryotes: initiation, elongation and termination. Replication enzymes of prokaryotes.

- Start of the synthesis, role of proteins in the preparation of DNA
- Leading and lagging strand, difference, additional enzymes on the lagging strands
- DNA-dependent DNA polymerase 3 type: subunits and their functions
- Theta and rolling circle replication, difference

9. Replication stages in eukaryotes: initiation, elongation and termination. Replication enzymes of eukaryotes: types and functions.

- Replication start in eukaryotes
- Telomeres role and structure
- Leading and lagging strands
- Initiation of replication
- Initiation of replication, cell cycle S-phase
- ε and δ polymerases
- Differences between eu- and prokaryotic DNA

10. Transcription as an intermediate stage of gene expression. Stages of transcription (initiation, elongation and termination).

- Definition of transcription
- Role of promoter in the initiation of transcription, formation of the transcription bubble, abortive initiation
- Formation of the transcription bubble, abortive initiation
- Transcription regulation in eukaryotes: transcription factors, enhancers, silencers
- Special DNA sequences involved in transcription
- RNA polymerases involved in prokaryotic and eukaryotic transcription
- Elongation of transcription
- Termination of transcription

11. Translation of proteins. Protein as a product of gene expression.

- Definitions of translation, genetic code, and triplets
- Levels of protein structure
- Role of ribosomes in translation

- Initiation of translation
- Start and stop codons
- Elongation of translation
- Termination of translation
- Post-translational modifications
- Protein folding

12. DNA repair mechanisms.
    - Consequences of DNA damage for the cell
    - Error-prone DNA polymerases (translation synthesis)
    - Base excision repair, nucleotide excision repair
    - Mismatch repair
    - Non-homologous end joining
    - Homologous recombination
    - Microhomology-mediated end joining
    - Accuracy of DNA repair mechanisms
13. Recombinant DNA technology: cloning vectors. Restriction enzymes and ligases.
    - Types of cloning vectors
    - Features of cloning vectors
    - Restriction endonucleases and ligases: definitions, usage for cloning vectors
    - Selection of transformed bacteria
    - Definition of cell competence
    - Confirmation of assembled vector structure
    - Expression vectors
    - Protein production via vectors
14. Polymerase chain reaction. Principle, variants, applications.
    - Definition of PCR
    - Stages of PCR
    - Description of PCR stages
    - Components needed for PCR
    - RT-PCR
    - PCR visualization, qPCR

- PCR for the detection of mutations
- PCR in practice

15. The chemical composition of proteins. Classification and properties of amino acids.

- Chemical structure of proteins
- Types of amino acid side chains
- Zwitterions, charged states of amino acids
- Influence of amino acids on protein structure
- Motifs in proteins
- Protein modifications

Part 2 - Microbiology

1. Bacterial taxonomy and nomenclature. Non-taxonomic groups: strains, serotypes. Describe taxonomy and identify non-taxonomic groups (if possible) for *Escherichia coli* O157:H7 and *Lactobacillus* sp. ATCC 15578.

- Description of all taxonomic units
- Definition of strain
- Definition of serotype
- Description of *E.coli* and *Lactobacillus* strain/serotype

2. Define main ecological groups of bacteria depending on oxygen presence. What techniques can be used for cultivation of anaerobes? What techniques can be used to increase oxygenation for aerobes? Provide examples of aerobic and anaerobic organisms.

- Definitions of ecological groups of bacteria depending on oxygen presence
- Examples of techniques for anaerobes cultivation
- Examples of techniques for aerobic cultivation

3. Define main ecological groups of bacteria depending on temperature and pH. Adaptations to temperature: sigma factors, membrane fluidity, chaperones.

- Definitions of ecological groups of bacteria depending on temperature
- Definitions of ecological groups of bacteria depending on pH
- Description of each mechanism of adaptation with examples of specific molecules, enzymes and systems

4. Define isolate, pure culture, strain. Describe purpose of use for following growth media: general nutrient media, minimal media, enrichment media, selective media, differential media. Describe steps of Gram staining and how it can be used for microorganism identification.

- Definitions of isolate, pure culture, strain

- Description (purpose) for different types of growth media
- Description of Gram staining procedure and stains
- Application of Gram staining

5. Bacterial cell wall. Draw a scheme and describe the structure of Gram positive and Gram negative cell walls. Provide examples of two organisms for each group (different genera). On scheme, identify periplasmic space, proteins, lipopolysaccharide, teichoic acid. Identify features of *Mycoplasma* and *Mycobacteria* cell envelope. Do they stain by Gram staining? Provide at least one example of Gram positive and Gram negative organisms, *Mycoplasma*, *Mycobacteria*.

- Composition of Gram negative cell wall and scheme
- Composition of Gram positive cell wall and scheme
- Description of *Mycoplasma* envelope and its composition
- Description of *Mycobacteria* cell envelope and its composition
- Examples of microorganisms for each group

6. What is a biofilm? Describe stages of biofilm formation. Name at least 3 components of the biofilm matrix. Define biofilm subpopulations: fast growing, slow growing, persisters, mutants.

- Biofilm definition
- Stages of biofilm formation
- Matrix components
- Definition of 4 subpopulations

7. Give definitions of fed-batch culture, repeated fed-batch culture, batch culture, continuous culture. Draw a standard bacterial growth curve. Identify stages of growth. Describe level of protein synthesis and number of live and dead cells on each stage. What is quorum sensing and how it affects culture growth?

- Definitions of fed-batch culture, repeated fed-batch culture, batch culture, continuous culture
- Scheme, names of each growth phase, analysis of each stage
- Definition of quorum sensing, description of its effect on bacterial culture growth

8. Describe bacterial cell division. What is a Z ring? What is the difference between binary fission and budding? Provide examples of bacteria which have binary and budding types of division. What is a generation time?

- Description of bacterial cell division
- Z ring description
- Binary fission of bacteria
- Budding of bacteria
- Examples of bacteria for each type of division

- Definition of generation time

9. Bacteriophages. Describe lytic and lysogenic life cycle. What is a prophage? Examples of dsDNA and ssDNA bacteriophages. How bacteriophages P1 and T7 are used in genetic engineering?

- Definition of bacteriophages
- Description of lytic life cycle
- Lysogenic life cycle
- Definition of a prophage
- Example of dsDNA and ssDNA bacteriophages
- Bacteriophage P1 for temperature-dependent cell lysis
- T7 bacteriophage promoter for increased rate of gene expression

10. Describe and draw schemes of 3 main types of horizontal gene transfer in prokaryotes. Describe conditions of chemical transformation and electroporation. What are the features of competent cells in comparison to other strains?

- Description and scheme for transformation
- Conjugation
- Transduction
- Description of principle for chemical transformation
- Description of principle for electroporation
- Features of competent cells

11. Regulation of gene expression in bacteria. DNA folding, examples of histone-like proteins. Sigma factors. Regulator operons: *lac* operon, tryptophan operon.

- Description of DNA, nucleoid and histone-like proteins (HU, HNS, SMC)
- Definitions of sigma factors, their functioning with examples
- Description of *lac* operon functioning
- Description of *trp* operon functioning

12. Antibiotics targets. Mechanisms of antibiotics resistance (at least 3). Definition of multidrug antibiotics resistance. R plasmids.

- Antibiotics targets
- Corresponding mechanisms of resistance
- Definition of multidrug resistance
- Definition of R plasmid

13. Examples of antibiotics and their targets (at least 5). Bacteriocins: source, function. Antimicrobial peptides: source, function. Quorum quenchers: source, function.

- Examples of antibiotics and their targets
- Sources and mechanisms of bacteriocins
- Sources and mechanism of AMP
- Sources and mechanism of QQ

14. Bacterial antigens (O-, H-, Vi-antigen). Pathogenicity, virulence, attenuation. Virulence factors, pathogenicity islands. Colonization and invasion.

- Definition of O-, H-, Vi-antigen
- Definition of pathogenicity, virulence, attenuation
- Definition of virulence factors, pathogenicity islands
- Colonization and invasion

15. Definition and difference between microbiota and microbiome. Dysbiosis. Probiotics and prebiotics. Commensal and conditionally pathogenic bacteria. Mechanisms of regulation of intestinal microbiota composition (at least 3).

- Definition of microbiota and microbiome
- Definition of dysbiosis, probiotics and prebiotics
- Definition of commensal and conditionally pathogenic bacteria
- Mechanisms of regulation of intestinal microbiota composition

Part 3 – Cell biology

1. Provide the structure of a eukaryotic cell. Name non-membrane, single-membrane and double layered organelles. Briefly describe their main functions.

- Mitochondria: structure and functions
- Endoplasmic reticulum: structure and functions
- Golgi complex: structure and functions
- Cytoplasmic membrane: structure and functions
- Nucleus: structure and functions
- Centriole, purinosome, etc: structure and functions

2. Describe the structure of a eukaryotic nucleus and its membrane.

- Nuclear envelope, lamina: structure and functions
- Nuclear transport description

- Karyoplasm, nucleolus: structure and functions

3. Provide a scheme of human cell cycle. What are the main phases and regulators of the cell cycle?

- Definition of interphase and mitosis
- Main phases of cell cycle and their features
- Regulation of cell cycle progression by CDK complexes

4. Describe stages of mitotic cell division of a eukaryotic cell. What are the main phases and their characteristics?

- Definition of karyokinesis and cytokinesis
- Phases of karyokinesis and their features

5. Describe an anaerobic glucose oxidation process. How glucose is transported to the cell? What are the steps and products of glycolysis?

- Constant and insulin-dependent glucose transporters
- Hexokinase, aldolase, GAPDH and their reactions in glycolysis
- Other participating enzymes and their reactions

6. Provide a scheme of tricarboxylic acid cycle with its stages and compounds. Describe main functions of the cycle in the cell.

- Sequence of a cycle stages
- Formula of citrate, α-ketoglutarate, succinate, oxaloacetate
- Formula of *cis*-aconitate, isocitrate, succinyl-CoA, fumarate, malate
- Role of a compound in cell metabolism

7. Describe oxidative phosphorylation and its main stages. What are the complexes of the electron transport chain and what are their functions?

- Full name, function and features of Complex I
- Full name, function and features of Complex II
- Full name, function and features of Complex III
- Full name, function and features of Complex IV
- Full name, function and features of Complex V

8. Provide names and structures of non-essential and conditionally essential amino acids. Where does the biosynthesis of them take part inside the cell?

- Name and structure of amino acid

- Location and enzymatic process of biosynthesis

9. Describe types and mechanisms of membrane transport. Provide examples of compounds transported by each type.

- Description of membrane transport mechanism
- Examples of compounds transported by each listed mechanism

10. Draw a scheme of a typical optical microscope. What are the main parts of it? What is the principle of image production in brightfield, darkfield and phase-contrast microscopes?

- Components of a conventional microscope and their functions
- Principle of brightfield microscopy
- Principle of darkfield microscopy
- Principle of phase-contrast microscopy

11. What is the principle of enzymatic reaction? Provide a formula of Michaelis–Menten equation. How is this equation obtained, what is the Michaelis–Menten constant?

- Scheme of a typical enzymatic reaction
- Michaelis–Menten equation for enzymatic reaction
- Plot of reaction rate vs substrate concentration dependence
- Michaelis constant definition
- Differential representation of enzymatic reaction rate and its derivation

12. Signal transduction in human cells. What are primary transducers, receptors and secondary transducers? Provide examples.

- Definition of signal transduction
- Features of primary transducers
- Features of receptors
- Features of secondary transducers
- Examples of transducers and receptors, their cascades

13. Provide the main principle of optical absorbance and fluorescence in terms of applications in molecular biology.

- Definition of optical absorbance, Beer–Lambert law and its formulation
- Additivity (linear combination) of optical absorbance in mixtures
- The use of optical absorbance in molecular biology studies
- Definition of fluorescence in terms of energy during nonradiative transition

- Stokes shift illustration on a wavelength vs intensity plot
- The use of fluorescence in molecular biology studies

14. Name B vitamins and their role in human cellular metabolism.
    - Name of vitamin B
    - Role in human cellular metabolism

Формат проведения: тестирование проводится в очной форме в присутствии наблюдателя
Количество вариантов: вариант тестового задания формируется в случайном порядке из банка заданий
Количество вопросов/заданий в одном варианте: 6 (по 2 вопроса из каждого блока – Молекулярная биология, Микробиология, Клеточная биология)
Время выполнения: 120 минут

Система оценивания

Полнота ответа / Результат	**Количество баллов**
за вопрос/задание	
полный правильный ответ	10
частично правильный ответ	1-9*
полностью неверный (или отсутствующий) ответ	0
* в зависимости от вопроса/задания	

Минимальное количество баллов за выполнение варианта тестового задания – 0.
Максимальное количество баллов за выполнение варианта тестового задания – 60.

Студент, набравший 60 % и более баллов (36 и более баллов из 60 возможных), успешно проходит аттестационное испытание.
Студент, набравший менее 60 % (менее 36 баллов из 60 возможных) баллов, считается не прошедшим аттестационное испытание и не готовым к освоению образовательной программы.

Ответы на вопросы/задания сдаются в письменном виде на английском языке. Оценивание проводится в соответствии с представленными ниже критериями.

Критерии оценивания

Вопрос/задание	Критерий*	Количество баллов**	
		промежуточное	итоговое
Part 1 - Molecular biology			
1. The central dogma of molecular biology. Semi-conservative DNA replication. Experiments that confirmed semi-conservative DNA replication.	Definition of the central dogma	-	1
	Exceptions of the central dogma	-	1
	Relation of a gene and the central dogma	-	1
	Definition of transcription and translation	0,5 за каждое определение	1
	Role of DNA for data storage	-	1
	Role of RNA for information transition	-	1
	Role of proteins as effectors	-	1
	Schematic description of a replication process	-	1
	Experiments of Meselson and Stahl	-	2
2. Nucleosides, nucleotides and their examples. Purines and pyrimidines nitrogenous bases. Biological roles of nucleotides in cells.	Nucleosides and nucleotides: definitions and difference	0,67 за каждое определение	2
		0,67 за название отличий	
	Nucleotide composition of DNA and RNA	-	1
	Difference of sugars in DNA and RNA	-	1
	Difference of the free nucleotides and associated into a string	-	1
	Purines and pyrimidines: structure and difference in hydrogen bonds	1,5 за каждый пункт (структура / название отличий)	3
	Roles of nucleotides in cell	-	2
3. The principles of DNA packaging in eukaryotic and prokaryotic cells. The structure of nucleosomes.	Difference in nucleic acid location in pro and eukaryotic	-	1
	Forms of DNA in the cell	-	1
	DNA forms and stability, supercoiling	1 за каждый пункт (формы и стабильность ДНК / суперскручивание)	2
	Histone types, nucleosome structure	1 за каждый пункт (типы гистонов / структура нуклеосом)	2
	Regulation of expression through the nucleosomes and condensation	-	2
	Solenoid structure, chromosomal structure	1 за каждый пункт (структура соленоида / структура хромосом)	2
4. The main types of RNA: structure and functions.	Main types of RNA, their functions	1 за каждый пункт (основные типы РНК / их функции)	2

	mRNA: production and modification	1 за каждый пункт (получение мРНК / модификация)	2
	tRNA: structure and basic features	0,5 за каждый пункт (структура тРНК / основные характеристики)	1
	rRNA in eukaryotic and prokaryotic organisms	1 за каждый пункт (рРНК в эукариотических клетках / рРНК в прокариотических клетках	2
	Conservative regions of features of RNA: locations and functions	0,5 за каждый пункт (расположение консервативных областей / их функции)	1
	microRNA, snRNA, lnRNA, minRNA: types and functions	-	2
5. Genetic code. The essence of genetic coding. Basic properties and universality of the genetic code.	GenCode definition	-	1
	Triplets in code	-	1
	Degeneration of code	-	1
	Universality of code	-	1
	Polarity of code	-	1
	Non-overlapping of code	-	1
	Unambiguousity of code	-	1
	ORF in code	-	1
	Stop codons	-	1
	Start codon	-	1
6. The structure of prokaryotic genes: coding sequence and promoter.	Operonic structure of prokaryotic genes, introns in prokaryotes	-	1
	Polycistronic operon structure, role of RBS	1 за каждый пункт (структура полицистронного оперона / роль рибосомосвязывающего центра)	2
	Promoter-operator relationship, role of promoter	1,5 за каждый пункт (связь промоутер-оператор / роль промоутера)	3
	Start codon, genetic code modification	1 за каждый пункт (стартовый кодон / модификация генетического кода)	2
	Enhancers and silencers	1 за каждый пункт (усилители / глушители)	2
7. The mosaic structure of eukaryotic genes (introns and exons), organization of promoters.	Exon-intron structure, difference from prokaryotic organisms, alternative splicing, mechanisms of splicing	1,25 за каждый пункт (структура экзон-интрона / отличие от прокариотических	5

		организмов / альтернативный сплайсинг / механизмы сплайсинга)	
	Gene clusters definition	-	1
	Transcription factors and its role	1 за каждый пункт (факторы транскрипции / их роль)	2
	Structural elements of the promoter	-	2
8. Replication stages in prokaryotes: initiation, elongation and termination. Replication enzymes of prokaryotes.	Start of the synthesis, role of proteins in the preparation of DNA	1 за каждый пункт (начало синтеза / роль белков в получении ДНК)	2
	Leading and lagging strand, difference, additional enzymes on the lagging strands	1 за каждый пункт (ведущая и отстающая нити / их разница / дополнительные ферменты на отстающих нитях)	3
	DNA-dependent DNA polymerase 3 type: subunits and their functions	1,5 за каждый пункт (субъединицы фермента / их функции)	3
	Theta and rolling circle replication, difference	0,67 за определение каждого вида репликации	2
		0,67 за название отличий	
9. Replication stages in eukaryotes: initiation, elongation and termination. Replication enzymes of eukaryotes: types and functions.	Replication start in eukaryotes	-	1
	Telomeres: role and structure	1 за каждый пункт (роль теломеров / их структура)	2
	Leading and lagging strands	0,5 за каждое определение	1
	Initiation of replication	-	1
	Initiation of replication, cell cycle S-phase	1 за каждый пункт (инициация репликации / S-фаза клеточного цикла)	2
	ε and δ polymerases	1 за каждое определение	2
	Differences between eu- and prokaryotic DNA	-	1
10. Transcription as an intermediate stage of gene expression. Stages of transcription (initiation, elongation and termination).	Definition of transcription	-	1
	Role of promoter in the initiation of transcription, formation of the transcription bubble, abortive initiation	0,67 за каждый пункт (роль промоутера / формирование транскрипционного пузыря / прерванная инициация)	2
	Transcription regulation in eukaryotes: transcription factors, enhancers, silencers	0,33 за каждый пункт (факторы транскрипции, усилители, глушители)	1
	Special DNA sequences involved	-	2

	in transcription		
	RNA polymerases involved in prokaryotic and eukaryotic transcription	1 за каждый пункт (РНК полимераза, участвующая в транскрипции прокариот / в транскрипции эукариот)	2
	Elongation of transcription	-	1
	Termination of transcription	-	1
11. Translation of proteins. Protein as a product of gene expression.	Definitions of translation, genetic code, and triplets	0,33 за каждое определение	1
	Levels of protein structure	-	2
	Role of ribosomes in translation	-	1
	Initiation of translation	-	1
	Start and stop codons	-	1
	Elongation of translation	-	1
	Termination of translation	-	1
	Post-translational modifications	-	1
	Protein folding	-	1
12. DNA repair mechanisms.	Consequences of DNA damage for the cell	-	1
	Error-prone DNA polymerases (translation synthesis)	-	1
	Base excision repair, nucleotide excision repair	1 за каждый пункт (эксцизионная репарация оснований ДНК / нуклеотидов)	2
	Mismatch repair	-	1
	Non-homologous end joining	-	1
	Homologous recombination	-	1
	Microhomology-mediated end joining	-	1
	Accuracy of DNA repair mechanisms	-	2
13. Recombinant DNA Technology: cloning vectors. Restriction enzymes and ligases.	Types of cloning vectors	-	1
	Features of cloning vectors	-	1
	Restriction endonucleases and ligases: definitions, usage for cloning vectors	0,67 за каждое определение 0,67 за описание использования	2
	Selection of transformed bacteria	-	1
	Definition of cell competence	-	1
	Confirmation of assembled vector structure	-	1
	Expression vectors	-	1
	Protein production via vectors	-	2
14. Polymerase chain reaction. Principle, variants, applications.	Definition of PCR	-	1
	Stages of PCR	-	1
	Description of PCR stages	0,33 за описание каждого этапа	1
	Components needed for PCR	-	1
	RT-PCR	-	1
	PCR visualization, qPCR	1	2

		за каждый пункт (визуализация ПЦР / количественная ПЦР)	
	PCR for the detection of mutations	-	2
	PCR in practice	-	1
15. The chemical composition of proteins. Classification and properties of amino acids.	Chemical structure of proteins	-	1
	Types of amino acid side chains	-	3
	Zwitterions, charged states of amino acids	-	1
	Influence of amino acids on protein structure	-	1
	Motifs in proteins	-	2
	Protein modifications	-	2
Part 2 - Microbiology			
1. Bacterial taxonomy and nomenclature. Non-taxonomic groups: strains, serotypes. Describe taxonomy and identify non-taxonomic groups (if possible) for Escherichia coli O157:H7 and Lactobacillus sp. ATCC 15578.	Description of all taxonomic units	1 за описание каждой таксономической единицы	6
	Definition of strain	-	1,5
	Definition of serotype	-	1,5
	Description of *E.coli* and *Lactobacillus* strain/serotype	0,5 за описание каждого вида бактерий	1
2. Define main ecological groups of bacteria depending on oxygen presence. What techniques can be used for cultivation of anaerobes? What techniques can be used to increase oxygenation for aerobes? Provide examples of aerobic and anaerobic organisms.	Definitions of ecological groups of bacteria depending on oxygen presence	1 за описание каждой группы	5
	Examples of techniques for anaerobes cultivation	0,22 за каждый пример	2
	Examples of techniques for aerobic cultivation	1 за каждый пример	3
3. Define main ecological groups of bacteria depending on temperature and pH. Adaptations to temperature: sigma factors, membrane fluidity, chaperones.	Definitions of ecological groups of bacteria depending on temperature	0,43 за описание каждой группы	3
	Definitions of ecological groups of bacteria depending on pH	0,5 за описание каждой группы	4
	Description of each mechanism of adaptation with examples of specific molecules, enzymes and systems	1 за описание каждого механизма	3
4. Define isolate, pure culture, strain. Describe purpose of use for following growth media: general nutrient media, minimal media, enrichment media, selective media, differential media. Describe steps of Gram staining and how it can be used for microorganism identification.	Definitions of isolate, pure culture, strain	1 за каждое определение	3
	Description (purpose) for different types of growth media	1 за каждое описание	5
	Description of Gram staining procedure and stains	-	1,5
	Application of Gram staining	-	0,5

5. Bacterial cell wall. Draw a scheme and describe the structure of Gram positive and Gram negative cell walls. Provide examples of two organisms for each group (different genera). On scheme, identify periplasmic space, proteins, lipopolysaccharide, teichoic acid. Identify features of Mycoplasma and Mycobacteria cell envelope. Do they stain by Gram staining? Provide at least one example of Gram positive and Gram negative organisms, Mycoplasma, Mycobacteria.	Composition of Gram negative cell wall and scheme	0,25 за название каждого компонента	2
		0,25 за схематичное изображение каждого компонента	
	Composition of Gram positive cell wall and scheme	0,25 за название каждого компонента	2
		0,25 за схематичное изображение каждого компонента	
	Description of *Mycoplasma* envelope and its composition	-	2
	Description of *Mycobacteria* cell envelope and its composition	-	2
	Examples of microorganisms for each group	0,5 за каждый пример	2
6. What is a biofilm? Describe stages of biofilm formation. Name at least 3 components of the biofilm matrix. Define biofilm subpopulations: fast growing, slow growing, persisters, mutants.	Biofilm definition	1	1
	Stages of biofilm formation	0,8 за описание каждой стадии	4
	Matrix components	0,6 за название каждого компонента	3
	Definition of 4 subpopulations	0,5 за каждое определение	2
7. Give definitions of fed-batch culture, repeated fed-batch culture, batch culture, continuous culture. Draw a standard bacterial growth curve. Identify stages of growth. Describe level of protein synthesis and number of live and dead cells on each stage. What is quorum sensing and how it affects culture growth?	Definitions of fed-batch culture, repeated fed-batch culture, batch culture, continuous culture	1 за каждое определение	4
	Scheme, names of each growth phase, analysis of each stage	1 за описание каждой фазы	4
	Definition of quorum sensing, description of its effect on bacterial culture growth	1 за каждый пункт (определение чувства кворума / описание его влияния на рост бактериальной культуры)	2
8. Describe bacterial cell division. What is a Z ring? What is the difference between binary fission and budding? Provide examples of bacteria which have binary and budding types of division. What is a generation time?	Description of bacterial cell division	-	1
	Z ring description	-	2
	Binary fission of bacteria	-	2
	Budding of bacteria	-	2
	Examples of bacteria for each type of division	0,5 за каждый пример	2
	Definition of generation time	-	1
9. Bacteriophages. Describe lytic and lysogenic life cycle. What is a prophage? Examples of dsDNA and ssDNA bacteriophages. How	Definition of bacteriophages	-	1
	Description of lytic life cycle	-	2
	Lysogenic life cycle	-	2
	Definition of a prophage	-	1
	Example of dsDNA and ssDNA	0,5	2

bacteriophages P1 and T7 are used in genetic engineering?	bacteriophages	за каждый пример	
	Bacteriophage P1 for temperature-dependent cell lysis	-	1
	T7 bacteriophage promoter for increased rate of gene expression	-	1
10. Describe and draw schemes of 3 main types of horizontal gene transfer in prokaryotes. Describe conditions of chemical transformation and electroporation. What are the features of competent cells in comparison to other strains?	Description and scheme for transformation	-	2
	Conjugation	-	2
	Transduction	-	2
	Description of principle for chemical transformation	-	1
	Description of principle for electroporation	-	1
	Features of competent cells	0,4 за каждую особенность	2
11. Regulation of gene expression in bacteria. DNA folding, examples of histone-like proteins. Sigma factors. Regulator operons: lac operon, tryptophan operon.	Description of DNA, nucleoid and histone-like proteins (HU, HNS, SMC)	0,67 за описание каждого объекта	2
	Definitions of sigma factors, their functioning with examples	1 за каждый пункт (определение сигма-факторов / их функционирование с примерами)	2
	Description of *lac* operon functioning	-	4
	Description of *trp* operon functioning	-	2
12. Antibiotics targets. Mechanisms of antibiotics resistance (at least 3). Definition of multidrug antibiotics resistance. R plasmids.	Antibiotics targets	1 за каждый пример	5
	Corresponding mechanisms of resistance	1 за описание каждого механизма	3
	Definition of multidrug resistance	-	1
	Definition of R plasmid	-	1
13. Examples of antibiotics and their targets (at least 5). Bacteriocins: source, function. Antimicrobial peptides: source, function. Quorum quenchers: source, function.	Examples of antibiotics and their targets	0,5 за каждый пример антибиотика	5
		0,5 за название мишеней каждого антибиотика	
	Bacteriocins: sources and mechanisms	1 за каждый пункт (источники бактериоцинов / механизмы их действия)	2
	AMP: sources and mechanisms	1 за каждый пункт (источники антимикробных пептидов / механизмы их действия)	2
	QQ: sources and mechanisms	0,5 за каждый пункт (источники средств для подавления кворума /	1

		механизмы их действия)	
14. Bacterial antigens (O-, H-, Vi-antigen). Pathogenicity, virulence, attenuation. Virulence factors, pathogenicity islands. Colonization and invasion.	Definition of O-, H-, Vi-antigen	1 за каждое определение	3
	Definition of pathogenicity, virulence, attenuation	1 за каждое определение	3
	Definition of virulence factors, pathogenicity islands	1 за каждое определение	2
	Colonization, invasion	1 за каждое определение	2
15. Definition and difference between microbiota and microbiome. Dysbiosis. Probiotics and prebiotics. Commensal and conditionally pathogenic bacteria. Mechanisms of regulation of intestinal microbiota composition (at least 3).	Definition of microbiota and microbiome	1 за каждое определение	2
	Definition of dysbiosis, probiotics and prebiotics	1 за каждое определение	3
	Definition of commensal and conditionally pathogenic bacteria	1 за каждое определение	2
	Mechanisms of regulation of intestinal microbiota composition	1 за описание каждого механизма	3
Part 3 – Cell biology			
1. Provide the structure of a eukaryotic cell. Name non-membrane, single-membrane and double layered organelles. Briefly describe their main functions.	Mitochondria: structure and functions	1 за каждый пункт (структура митохондрий / их функции)	2
	Endoplasmic reticulum: structure and functions	0,75 за каждый пункт (структура эндоплазматического ретикулума / его функции)	1,5
	Golgi complex: structure and functions	0,75 за каждый пункт (структура аппарата Гольджи / его функции)	1,5
	Cytoplasmic membrane: structure and functions	0,75 за каждый пункт (структура цитоплазматической мембраны / ее функции)	1,5
	Nucleus: structure and functions	0,75 за каждый пункт (структура ядра / его функции)	1,5
	Centriole, purinosome, etc: structure and functions	0,5 за описание структуры каждого примера	2
		0,5 за описание функций каждого примера	
2. Describe the structure of a eukaryotic nucleus and its membrane.	Nuclear envelope, lamina: structure and functions	1 за описание структуры каждого примера	4
		1 за описание функций каждого примера	
	Nuclear transport description	-	3
	Karyoplasm, nucleolus: structure and functions	0,75 за описание структуры каждого примера	3

		0,75 за описание функций каждого примера	
3. Provide a scheme of human cell cycle. What are the main phases and regulators of the cell cycle?	Definition of interphase and mitosis	0,5 за каждое определение	1
	Main phases of cell cycle and their features	1 за название каждой фазы	6
		1 за описание особенностей каждой фазы	
	Regulation of cell cycle progression by CDK complexes	1 за каждый пример	3
4. Describe stages of mitotic cell division of a eukaryotic cell. What are the main phases and their characteristics?	Definition of karyokinesis and cytokinesis	1 за каждое определение	2
	Phases of karyokinesis and their features	1 за название каждой фазы	8
		1 за описание особенностей каждой фазы	
5. Describe an anaerobic glucose oxidation process. How is glucose transported to the cell? What are the steps and products of glycolysis?	Constant and insulin-dependent glucose transporters	1 за каждое определение	2
	Hexokinase, aldolase, GAPDH and their reactions in glycolysis	1 за описание каждого фермента	6
		1 за описание реакций в гликолизе каждого фермента	
	Other participating enzymes and their reactions	0,5 за описание каждого фермента	2
		0,5 за описание реакций каждого фермента	
6. Provide a scheme of tricarboxylic acid cycle with its stages and compounds. Describe main functions of the cycle in the cell.	Sequence of a cycle stages	-	2
	Formula of citrate, α-ketoglutarate, succinate, oxaloacetate	0,75 за каждую формулу	3
	Formula of cis-aconitate, isocitrate, succinyl-CoA, fumarate, malate	0,6 за каждую формулу	3
	Role of a compound in cell metabolism	0,5 за каждый пример	2
7. Describe oxidative phosphorylation and its main stages. What are the complexes of the electron transport chain and what are their functions?	Full name, function and features of Complex I	0,67 за каждый пункт (название комплекса / функции / особенности)	2
	Full name, function and features of Complex II	0,33 за каждый пункт (название комплекса / функции / особенности)	1
	Full name, function and features of Complex III	0,67 за каждый пункт (название комплекса / функции /	2

		особенности)	
	Full name, function and features of Complex IV	0,67 за каждый пункт (название комплекса / функции / особенности)	2
	Full name, function and features of Complex V	1 за каждый пункт (название комплекса / функции / особенности)	3
8. Provide names and structures of non-essential and conditionally essential amino acids. Where does the biosynthesis of them take part inside the cell?	Name and structure of amino acid	0,25 за название каждой аминокислоты	7
		0,25 за описание структуры каждой аминокислоты	
	Location and enzymatic process of biosynthesis	1,5 за каждый пункт (местоположение биосинтеза / ферментативный процесс)	3
9. Describe types and mechanisms of membrane transport. Provide examples of compounds transported by each type.	Description of membrane transport mechanism	1,5 за описание каждого механизма	6
	Examples of compounds transported by each listed mechanism	1 за каждый пример	4
10. Draw a scheme of a typical optical microscope. What are the main parts of it? What is the principle of image production in brightfield, darkfield and phase-contrast microscopes?	Components of a conventional microscope and their functions	1 за каждый пункт (составляющие микроскопа / их функции)	2
	Principle of brightfield microscopy	-	2
	Principle of darkfield microscopy	-	2
	Principle of phase-contrast microscopy	-	4
11. What is the principle of enzymatic reaction? Provide a formula of Michaelis–Menten equation. How is this equation obtained, what is the Michaelis–Menten constant?	Scheme of a typical enzymatic reaction	-	1
	Michaelis–Menten equation for enzymatic reaction	-	1
	Plot of reaction rate vs substrate concentration dependence	-	2
	Michaelis constant definition	-	2
	Differential representation of enzymatic reaction rate and its derivation	-	4
12. Signal transduction in human cells. What are primary transducers, receptors and secondary transducers? Provide examples.	Definition of signal transduction	-	1
	Features of primary transducers	-	1
	Features of receptors	-	1
	Features of secondary transducers	-	1
	Examples of transducers and receptors, their cascades	1,5 за каждый пример	6
13. Provide the main principle of optical absorbance and fluorescence	Definition of optical absorbance, Beer–Lambert law and its formulation	-	1

in terms of applications in molecular biology.	Additivity (linear combination) of optical absorbance in mixtures	-	2
	The use of optical absorbance in molecular biology studies	-	2
	Definition of fluorescence in terms of energy during nonradiative transition	-	2
	Stokes shift illustration on a wavelength vs intensity plot	-	1
	The use of fluorescence in molecular biology studies	-	2
14. Name B vitamins and their role in human cellular metabolism.	Name of vitamin B	0,5 за каждый пример	2,5
	Role in human cellular metabolism	1,5 за каждый пример	7,5
Примечание: * часть вопроса/задания, которую необходимо раскрыть ** если студент правильно раскрывает критерий (подпункт критерия), то получает указанное количество баллов, если критерий (подпункт критерия) не раскрыт или раскрыт неверно, то студент получает 0 баллов за критерий (подпункт критерия)			

Сумма набранных баллов за тестирование оценивается по правилу округления до целого значения.

На аттестационном испытании запрещается использовать записи, конспекты лекций и иные материалы, а также электронные устройства.

При использовании данных материалов ответы студента аннулируются, аттестационное тестирование считается не пройденным.

ПРИЛОЖЕНИЕ 3

Приложение к распоряжению от 13.01.2023 № 4

Система перевода показателей в балльно-рейтинговую систему

Показателями академической успеваемости и учебно-научной активности студентов, которые учитываются при проведении аттестационного собеседования, являются: академическая разница, наличие достижений по научной и учебной деятельности, средний балл по академической справке.

Данные показатели могут быть учтены для всех направлений подготовки, за которыми закреплены образовательные программы Химико-биологического кластера.

Для осуществления ранжирования студентов в общем списке в случае конкурса на вакантные бюджетные места все показатели переводятся в балльно-рейтинговую систему согласно таблице ниже.

В случае если студент не проходит аттестационное тестирование, он считается не прошедшим аттестационное испытание, и баллы по показателям не учитываются.

Система перевода показателей академической успеваемости и учебно-научной активности студентов в балльно-рейтинговую систему

№	Показатель	Критерий измерения	Балл
1	Академическая разница*	0-2 дисциплины/практики	5
		3-5 дисциплин/практик	3
		6-8 дисциплин/практик	1
		более 8 дисциплин/практик	0
2	Наличие достижений	победитель или призер международных олимпиад / соревнований	3 за каждое достижение
		наличие статьи в журнале, рецензируемом базой Scopus, Web of Science	3 за каждое достижение
		участие в международной конференции/симпозиуме	3 за каждое достижение
		победитель или призер всероссийских олимпиад / соревнований	2 за каждое достижение
		наличие статьи в журнале, рецензируемом ВАК	2 за каждое

			достижение
		участие во всероссийской конференции/симпозиуме	2 за каждое достижение
		победитель или призер региональных или внутривузовских олимпиад / соревнований	1 за каждое достижение
		наличие статьи в журнале, рецензируемом РИНЦ	1 за каждое достижение
		участие в региональной/внутривузовской конференции/симпозиуме	1 за каждое достижение
		прочие достижения	1 за каждое достижение
		нет достижений	0
3	Средний балл**	4,7-5,0	5
		4,3-4,6	4
		3,9-4,2	3
		3,5-3,8	2
		3,0-3,4	1
		менее 3,0	0

* Академическая разница подсчитывается на основании количества дисциплин/практик (не форм контроля)

** Средний балл учитывается согласно академической справке по правилу округления значения до десятичного знака