

Biology and biotechnology: second-round sample tasks

Task 1 (choose one correct answer)

Which enzyme causes the cleavage of nucleic acid molecules of the free ends of the molecule?

1. Endonuclease
2. Exonuclease
3. Phosphatase
4. Revertase
5. Translocase

The correct answer is 2.

The question is worth 1 point.

Task 2 (choose one correct answer)

Which enzymes are used to amplify DNA?

1. kinases
2. restrictases
3. polymerase
4. topoisomerases
5. lyases

The correct answer is 3.

The question is worth 1 point.

Task 3 (choose one correct answer)

Which is the function of a promoter?

1. It encodes a repressor protein.
2. It encodes an inducer protein.
3. It is the site of attachment for RNA polymerase, where it starts transcription.
4. stops the translation
5. limits the work of enhancers

The correct answer is 3.

The question is worth 1 point.

Task 4 (choose one correct answer)

A working lactose operon is characterized by:

1. a low concentration of lactose;
2. the repressor protein located in the operator area;
3. ribosomes landing on a promoter;
4. RNA polymerase unable to overcome the operator;
5. ribosomes synthesizing a protein from mRNA.

The correct answer is 5.

The question is worth 1 point.

Task 5 (choose one correct answer)

Which level of biohazard is needed for working with yeast *S. cerevisiae*?

1. biohazard level 1
2. biohazard level 2
3. biohazard level 3
4. biohazard level 4
5. biohazard level 5

The correct answer is 1
The question is worth 1 point.

Task 6 (choose correct answers)**Bacteria are used in biotech production to obtain:**

1. vitamins;
2. dairy products;
3. flour;
4. soaps;
5. bread.

The correct answers are 1 and 2.
The question is worth 3 points.

Task 7 (choose correct answers)**Which molecules are enzymes?**

1. sucrose
2. maltase
3. succinate dehydrogenase
4. riboflavin
5. cyclooxygenase

The correct answers are 2, 3, and 5.
The question is worth 3 points.

Task 8 (a detailed answer is required)

A virus genome consists of double-stranded DNA and contains 20 percent adenine, 20 percent thymine, 30 percent cytosine, and 30 percent guanine. The genomic DNA is digested with a restriction enzyme that cuts the DNA at the AGCT site. **Calculate the average number of fragments if the virus genomic DNA is 300 kb. Give a detailed answer.**

The correct answer is 1080.

Assessment criteria:

The probability of occurrence of the site of AGCT has been determined:

$$p(\text{AGCT}) = p(\text{A}) p(\text{G}) p(\text{C}) p(\text{T}) = 0.2 \cdot 0.2 \cdot 0.3 \cdot 0.3 = 0.0036 \text{ (3 points)}$$

The number of fragments at a length of 300,000 bp has been calculated:

$$N = 300000 \cdot p(\text{AGCT}) = 1080 \text{ (3 points)}$$

The highest possible score is 6 points.

Task 9 (choose one correct answer)**Which set of chromosomes is characteristic of a haploid human cell?**

1. n
2. 2n
3. 3n
4. 4n
5. 46 chromosomes

The correct answer is 1.
The question is worth 1 point.

Task 10 (choose one correct answer)**Which plants have a root system but do not form seeds?**

1. Gymnosperms
2. Angiosperms

3. Mosses
4. Ferns
5. Brown algae

The correct answer is 4

The question is worth 1 point.

Task 11 (choose one correct answer)

How many germ layers are formed during the embryogenesis of the coelenterates?

1. 1
2. 2
3. 3
4. 4
5. 5

The correct answer is 2.

The question is worth 1 point.

Task 12 (choose one correct answer)

Which type of nervous system is characteristic of a flatworm?

1. tubular
2. nodal
3. ladder-like
4. diffuse
5. missing

The correct answer is 3.

The question is worth 1 point.

Task 13 (choose one correct answer)

Which structure of the spermatozoon is involved in fertilization?

1. acrosome
2. mitochondrion
3. cortical granules
4. basal body
5. nucleus

The correct answer is 1.

The question is worth 1 point.

Task 14 (choose correct answers)

Which phases of mitosis are distinguished between prophase and telophase?

1. anaphase
2. metaphase
3. antiphase
4. homophase
5. hemiphase

The correct answers are 1 and 2.

The question is worth 3 points.

Task 15 (choose correct answers)

Which processes are NOT characteristic of meiotic anaphase 2?

1. homologous chromosomes moving to the poles;
2. sister chromatids diverging towards the poles;

3. a $2n$, $4c$ chromosome set;
4. an n , c chromosome set;
5. crossing over.

The correct answers are 1, 3, 4, and 5.

The question is worth 3 points.

Task 16 (a detailed answer is required)

In peas, the flower color depends on two genes. Producing red flowers with normal anthocyanin synthesis requires at least one dominant allele of each gene.

Draw a genetic diagram and determine the probability of the offspring from a cross between AaBB and AaBb parents having red flowers.

The correct answer is 75 percent.

Assessment criteria:

The genetic diagram has been drawn; the phenotypes of the parents have been shown: 3 points

Drawn Punnett grids/crossing patterns for each of the genes: 3 points

The probabilities of a favorable sign in each lattice are determined - 3 points

Calculated the total probability of an event by multiplying all the probabilities: 3 points

The question is worth 1 point.2 points

Task 17 (choose one correct answer)

Which virus uses reverse transcription?

1. Bacteriophage T2
2. Variola virus
3. Human immunodeficiency virus
4. Tobacco mosaic virus
5. Human herpes virus

The correct answer is 3

The question is worth 1 point.

Task 18 (choose one correct answer)

Revertase inhibitors can be used against:

1. bacteria;
2. herpesviruses;
3. orthomyxoviruses;
4. retroviruses;
5. picornaviruses.

The correct answer is 4

The question is worth 1 point.

Task 19 (choose one correct answer)

A bacterial cell contains:

1. 80S ribosomes;
2. Centriole
3. circular DNA
4. Endoplasmic reticulum
5. Lysosomes

The correct answer is 3

The question is worth 1 point.

Task 20 (choose one correct answer)**Which is a bacterial infection:**

1. Chickenpox
2. Flu
3. HIV
4. Trichomonas
5. Cholera

The correct answer is 5.

The question is worth 1 point.

Task 21 (choose one correct answer)**Which structure cannot be identified using a light microscope at a magnification of up to 1000 times?**

1. Ribosome
2. Vacuole
3. Nucleus
4. Plastids
5. Nucleolus

The correct answer is 1.

The question is worth 1 point.

Task 22 (choose correct answers)**The cells of which organisms do NOT contain mitochondria?**

1. Homo sapiens
2. *E. coli* bacteria
3. bacterium *Treponema pallidum*
4. *Penicillium* mold
5. *Pseudomonas aeruginosa* bacterium

The correct answers are 2, 3, and 5

The question is worth 3 points.

Task 23 (choose correct answers)**Which steps are part of viral DNA transcription?**

1. Initiation
2. Elongation
3. Termination
4. Degradation
5. Polarization

The correct answers are 1, 2, and 3.

The question is worth 3 points.

Task 24 (a detailed answer is required)

One division of an *E. coli* cell takes 20 minutes. There are 12,800 bacterial cells in the test tube with the nutrient mixture. **What law describes the number of cells? Provide the formula describing the dependence. How many cells were there in the test tube two hours earlier? Give a detailed answer.**

The correct answer is 200

Assessment criteria:

The formula $N(t) = N(0) \cdot 2^{T/t}$ has been provided (3 points).

The number of divisions: $k = 2 \text{ hours} / (1/3 \text{ hour}) = 6$ divisions

The number of bacteria increased $2^6 = 64$ times

The initial number of bacteria: $N(t)/64 = 200$ (3 points)

The question is worth 6 points.

Task 25 (choose one correct answer)

Which molecules can pass freely through the lipid layer of the neuron membrane?

1. glucose
2. Na^+ ion
3. alkali
4. acids
5. non-polar compounds

The correct answer is 5

The question is worth 1 point.

Task 26 (choose one correct answer)

Which hormone is produced in response to a lack of sodium salts?

1. thyroxine
2. glucagon
3. aldosterone
4. insulin
5. adrenalin

The correct answer is 3.

The question is worth 1 point.

Task 27 (choose one correct answer)

Which cells produce antibodies?

1. basophils
2. B-lymphocytes
3. NK lymphocytes
4. mast cells
5. chondrocytes

The correct answer is 2.

The question is worth 1 point.

Task 28 (choose one correct answer)

Which process lowers the heart rate?

1. parasympathetic nervous system activation
2. sympathetic nervous system activation
3. somatic nervous system activation
4. adrenaline release
5. norepinephrine release

The correct answer is 1.

The question is worth 1 point.

Task 29 (choose one correct answer)

Which of the following is true of passive immunity?

1. It develops in the course of a natural disease.
2. It is a result of vaccination.
3. It can be induced by injecting serum.

4. It is non-specific.
 5. It does not change throughout life.
- The correct answer is 3.

The question is worth 1 point.

Task 30 (choose correct answers)

The elements of specific immunity include:

1. lysozyme in saliva;
2. the complement system in the blood;
3. inflammatory response;
4. release of antibodies by B-lymphocytes;
5. induction of cell death by T cells.

The correct answers are 4 and 5.

The question is worth 3 points.

Task 31 (choose correct answers)

Which hormones do the adrenal glands secrete into the blood?

1. cortisol
2. aldosterone
3. adrenocorticotropin
4. adrenalin
5. somatotropin-releasing factor

The correct answers are 1, 2, and 4.

The question is worth 3 points.

Task 32 (a detailed answer is required)

Calculate how much oxygen can be transferred by one liter of blood in a human being if one erythrocyte contains 30 picograms of hemoglobin; 1 liter of blood has $5 \cdot 10^{12}$ erythrocytes; the molecular weight of hemoglobin is 64500 g/mol; hemoglobin has four polypeptide chains (each includes a heme capable of binding one oxygen molecule).

Assessment criteria

The hemoglobin mass in a liter of blood: $30 \text{ pg/pcs} \cdot 5 \cdot 10^{12} \text{ pcs} = 150 \text{ g}$ (3 points)

The amount of hemoglobin in a liter of blood: $150 \text{ g} / 64500 \text{ g/mol} = 2.32 \cdot 10^{-3} \text{ mol}$ (3 points)

The amount of oxygen: $2.32 \cdot 10^{-3} \text{ mol} \cdot 4 = 9.3 \cdot 10^{-3} \text{ mol}$ (3 points)

The volume of oxygen: $9.3 \cdot 10^{-3} \text{ mol} \cdot 22.4 \text{ l/mol} = 0.208 \text{ l}$ (3 points)

The question is worth 12 points.

Task 33 (choose one correct answer)

Which of the following is not true of translation?

1. Translation is carried out by ribosomes.
2. Translation requires nucleoside triphosphates.
3. Translation termination occurs with the help of the rho factor.
4. Proteins are synthesized during translation.
5. Initiation of translation in prokaryotes occurs with recognition of the start codon.

The correct answer is 3

The question is worth 1 point.

Task 34 (choose one correct answer)

Which of the following is true of transcription?

1. Transcription requires tRNAs.

2. Synthesis of a new RNA chain goes in the 3' to 5' direction.
3. Transcription is completed when a hairpin is formed in mRNA.
4. Transcription is completed with RNA polymerase landing on the operator.
5. Transcription begins with landing on the START codon.

The correct answer is 3

The question is worth 1 point.

Task 35 (choose one correct answer)

Which compounds do NOT contain nitrogen?

1. Urea
2. Amino acids
3. Nucleic acids
4. Fatty acids
5. Proteins

The correct answer is 4.

The question is worth 2 points.

Task 36 (choose one correct answer)

Which compounds comprise nucleotides?

1. amino acids, RNA, and protein
2. phosphate, sugar, and a nitrogenous base
3. amino group, carboxyl group, and radical
4. nitrogenous base and deoxyribose
5. deoxyribose and phosphate

The correct answer is 2.

The question is worth 1 point.

Task 37 (choose one correct answer)

Which food is rich in lipids?

1. potato tubers
2. blueberries
3. cod liver
4. egg white
5. beets

The correct answer is 3

The question is worth 1 point.

Task 38 (choose correct answers)

What chemical substances are part of the bacterial cell wall?

1. Starch
2. Murein
3. Chitin
4. Glycogen
5. Teichoic acids

The correct answer is 2, 5

The question is worth 3 points.

Task 39 (choose correct answers)

Which of the following statements are true of photosynthesis?

1. Oxygen is formed from a molecule of water.
2. Oxygen is formed from a molecule of carbon dioxide.

3. Oxygen is formed from a molecule of glucose.
4. Glucose is formed from a molecule of carbon dioxide.
5. Glucose is broken down into carbon dioxide molecules.

The correct answers are 1 and 4.

The question is worth 3 points.

Task 40 (a detailed answer is required)

The nucleic acid of a virus is known to contain 20 percent adenine, 30 percent guanine, 30 percent cytosine, and 20 percent thymine. **Describe the nucleic acid containing the genome of the virus.**

Correct answer: DNA, double-stranded.

Assessment criteria

Chargaff's rules have been mentioned: 1 point; Chargaff's rules have been applied (without a proper mention, expressed in own words), and the conclusion about 1 or 2 nucleic acid chains has been made: 3 points; it is stated that thymine is contained in DNA and uracil in RNA: 2 points; the type of nucleic acid has been identified based on the presence of thymine or uracil: 3 points.

The question is worth a total of 9 points.