Biology and Biotechnology: Second-round sample tasks for the Open Doors Postgraduate Track

The option includes 45 tasks, of which 27 entry-level test tasks with one correct answer (a correctly completed task is assessed at 1 point), 14 intermediate-level test tasks with several correct answers (a correctly completed task is assessed at 3 points), 4 advanced-level tasks with a detailed answer (a correctly completed task is assessed at 6-9 points).
For tasks with a detailed answer, assessment criteria and a standard answer are provided.

Biotechnology & Applied Microbiology

Task 1
Entry level task (1 point)

Bioobjects of phytobiotechnology include:

Choose one correct answer.

a) Protozoan cells
b) Bacteriophages
c) Ascomycete cells
d) Algae cells
e) Bacteria cells

Answer: d.

Task 2
Entry level task (1 point)

Changes in the nucleotide sequence of the DNA of a biological object as a result of the movement of a DNA transposon section are:

Choose one correct answer.

a) Phenotype change - modification
b) Mutation with a change in the number of chromosomes
c) Gene mutation
d) Deletion
e) Chromosomal mutation

Answer: b.

Task 3
Entry level task (1 point)

An amino acid produced using biotechnology is:

Choose one correct answer.

a) Antibiotic
b) A growth hormone
c) Insulin
d) Glycine
e) Leukocyte interferon

Answer: d.

Task 4
Entry level task (1 point)

Enzymes used to synthesize an RNA molecule using DNA as a template -

Choose one correct answer.

a) Restriction enzymes
b) Ligases
c) Endonucleases
d) Polymerases

Answer: d.

Task 5
Entry level task (1 point)

The pressure difference between rooms of different cleanliness classes is created for:

Choose one correct answer.

a) Creating staff comfort
b) Facilitating technological operations
c) Reducing the risk of contamination (contamination) of the manufactured product
d) Automatic closing of doors for the clean room

Answer: c.

Task 6
Intermediate level task (3 points)

Activation of the process of synthesis of a secondary metabolite (target product) - an antibiotic - occurs by:

Select all correct answers.

a) Inhibition of the main enzyme responsible for the process of amino acid synthesis
b) Suppression (repression) of the entire enzyme complex of enzymes responsible for the process of amino acid synthesis
c) Activation of the transcription process
d) Activation of the translation process
e) Repression of the transcription process

Answer: c, d.

Task 7
Intermediate level task (3 points)

Enzymes can be immobilized the following physical methods:

Select all correct answers.

a) Covalent bonding
b) Linking enzyme molecules together
c) Encapsulation
d) Inclusions in liposomes

Answer: c, d.

Task 8
Advanced level task (6 points)

Describe the method for isolating cell biomass by filtration.
List ways to speed up the filtration process.

Note: The assessment will consider the process and reasoning behind solving the task; merely providing the answer will not suffice.
Solution:
1. Answer: The method of isolating cell biomass by filtration involves retaining the biomass on a porous filter membrane. 2 points
2. Answer: Ways to speed up the filtration process:
a) Select a porous material (filter). - 1 point.
b) Carry out pressure filtration.- 1 point.
c) Use devices – vacuum pump.- 1 point.
d) Clean filters regularly. - 1 point.

Biology

Task 9
Entry level (1 point)

Determine the total number of chromosomes in 100 cells of an animal at the metaphase stage, if it is known that the karyotype of Drosophila melanogaster has 4 pairs of chromosomes:

Choose one correct answer.

a) 800
b) 400
c) 80
d) 1200
e) 40

Answer: a.

Task 10
Entry level (1 point)

The spermatid of the model animal Drosophila melanogaster contains the following set of chromosomes:

Choose one correct answer.

a) nc
b) n2c
c) 2n2c
d) 2n4c
e) 4n4c

Answer: a.

Task 11
Intermediate level (3 points)

Fungi of the genus Aspergillus during an experiment with changing cultivation parameters can reproduce by:

Select all correct answers.

a) Schizogony
b) Parthenogenesis

c) Conjugation
d) Division of hyphae (mycelium)
e) Formation of ascospores

Answer: d, e.

Task 12
Advanced level (8 points)

You have acquired 10 male and 10 non-fertilized female Drosophila melanogaster (fruit flies). The study is scheduled to begin 10 days after the purchase of the animals and the expected day of fertilization of the females. It is known that each female Drosophila melanogaster can lay up to 100 eggs at once, and the development period from egg to adult is 10 days, when the flies are kept at a temperature of 25°C.

1. Identify the type of development in *Drosophila melanogaster*.
2. List all stages of development in *Drosophila melanogaster*, starting from the egg.
3. Calculate the total number of different developmental stages of *Drosophila melanogaster* that will be available 10 days after the purchase of the animals and the expected fertilization. Assume no mortality at different stages.

Solution:

1. Answer: indirect (with metamorphosis) - 1 point;
with complete transformation, with complete metamorphosis– 1 point.
2. Answer: egg, larva, pupa in puparia, imago. – 1 point.
3. Answer: total number of different stages of development = (10x100=1 000+10 females+10 males) =1 020. – 5 points.

Genetics and heredity

Task 13
Entry level (1 point)

When describing a polyploid organism by specifying the number of chromosome sets, we provide a characterization of its:
Choose one correct answer.

a) Phenotype
b) Karyotype
c) Genotype
d) Reaction norms
e) Environmental factor

Answer: b.

Task 14
Entry level (1 point)

To conduct a study, you need a homozygous organism for a specific recessive trait. Which of the following organisms would be appropriate for your research?
Choose one correct answer.

a) aaBB
b) AaBB
c) AAVv
d) AaVv
e) AABB

Answer: a.

Task 15
Entry level (1 point)

In the virtual fly model, there are 8 pairs of chromosomes in the karyotype. Which karyotype represents a normal male in this virtual fly model?

Choose one correct answer.

a) 7A+XY
b) 14A+XX
c) 7A+XX
d) 14A+XO
e) 9A+ XY

Answer: d.

Task 16
Intermediate level (3 points)

Mutations that change the number of chromosomes in the karyotype include:

Select all the correct answers.

a) Nucleotide duplication
b) Nucleotide insertion
c) Deletion of the short arm of a chromosome
d) 44A+XXX
e) 45A+XXY

f) Nucleotide deletion

Answer: d, e.

Task 17
Intermediate level (3 points)

During the experiment, the DNA nucleotide sequence AAAGGGCCCTTT changed to AAAGGCCCTT. Analyze the DNA sequences and determine the changes that occurred during the experiment with the hereditary material:

Select all the correct answers.

a) Replacement of nucleotide G with A
b) Nucleotide A insertion
c) Nucleotide T insertion
d) Deletion of nucleotide G
e) Nucleotide T deletion
f) Replacement of nucleotide G with C

Answer: d, e.

Task 18
Advanced level (8 points)

You are conducting research on a model animal. During the study, you identified that the animal has a fourth blood group and a negative Rh factor.

1. Name the cell in which the proteins that determine blood type are located.
2. Name the cell in which the proteins that determine the Rh factor should be located.
3. In what cell structure are the proteins that determine blood type located?
4. In what cell structure should the proteins that determine the Rh factor be located?
5. How many proteins that determine blood group and Rh factor can be determined in this model animal?
6. List the proteins that determine the blood type of a virtual animal
7. Write down all the genotypes that can characterize this model animal.

Note: The assessment will consider the process and reasoning behind solving the task; merely providing the answer will not suffice.

Solution:

1. Answer: red blood cell. – 1 point.
2. Answer: red blood cell. – 1 point.
3. Answer: cytoplasmic membrane complex, including the glycocalyx. – 1 point.

4. Answer: cytoplasmic membrane complex, including the glycocalyx. – 1 point.
5. Answer: 2. – 1 point.
6. Answer: A and B. – 2 points.
7. Answer: I^AI^BRh-Rh- - 2 points.

Cell biology

Task 19
Entry level (1 point)

In an E. coli cell one can find:

Choose one correct answer.

a) Circular DNA molecule and murein protein
b) Core
c) Mitochondria
d) Chloroplasts
e) Centrioles

Answer: a.

Task 20
Entry level (1 point)

A leukocyte is characterized by the presence of:

Choose one correct answer.

a) Nucleus
b) Chloroplasts
c) Capsid
d) Cellulose cell wall
e) Starch grains

Answer: a.

Task 21
Intermediate level (3 points)

The double-membrane organelles of a eukaryotic cell are:

Select all the correct answers.

a) Endoplasmic reticulum
b) Mitochondria
c) Centriole
d) Leukoplast
e) Golgi complex

Answer: b, d.

Task 22
Intermediate level (3 points)

Growing plant tissues are:

Select all the correct answers.

a) Cambium
b) Bone
c) Meristem
d) Connecting
e) Nervous

Answer: a, c.

Ecology

Task 23
Entry level (1 point)

According to its functional role in the ecosystem, the tuberculosis bacillus (Koch bacillus) is classified as a consumer because it:

Choose one correct answer.

a) Feeds on ready-made organic matter
b) Synthesizes organic substances from inorganic ones
c) Releases oxygen
d) Decomposes organic substances to inorganic ones
e) Is the first link in the food chain

Answer: a.

Task 24
Entry level (1 point)

The habitat of the malaria plasmodium is the erythrocyte. What is special about this environment?

Choose one correct answer.

a) Presence of a protein-rich substrate
b) Abundance of light
c) Presence of oxygen
d) Presence of carbon dioxide
e) Presence of iron hydrogen sulfide

Answer: a.

Task 25
Intermediate level (3 points)

What abiotic factors can influence the development and survival of cyanobacteria on wooden surfaces of buildings?

Select all the correct answers.

a) Air humidity
b) Impregnation of wooden surfaces with synthetic chemical agents that prevent rotting
c) Sunlight
d) White mold
e) Putrefactive bacteria

Answer: a, c.

Task 26
Intermediate level (3 points)

Parasitic organisms - protozoa for humans are:

Select all the correct answers.

a) Guinea worm
b) White planaria
c) Flea
d) Ascaris
e) Malarial plasmodium
f) Giardia

Answer: e, f.

Microbiology

Task 27
Entry level (1 point)

Which microorganisms are eukaryotes?

Choose one correct answer.

a) Mycoplasmas
b) Ascomycetes
c) Rickettsia
d) Bacteriophages
e) Bifidobacteria

Answer: b.

Task 28
Entry level (1 point)

The rod-shaped cells have:

Choose one correct answer.

a) Clostridia
b) Mycoplasma
c) Vibrio
d) Spirochete
e) L-form

Answer: a.

Task 29
Entry level (1 point)

Copying of hereditary information in bacteria occurs in the matrix known as:

Choose one correct answer.

a) Circular DNA molecule
b) Circular RNA molecule
c) Linear DNA molecule
d) DNA double helix

Answer: a.

Task 30
Entry level (1 point)

To obtain a bacterial culture resistant to aerobic environmental conditions, it is necessary to use a storage medium and cultivation conditions with:

Choose one correct answer.

a) Increased oxygen content
b) Low oxygen content
c) Elevated temperature
d) High blood pressure
e) Low temperature

Answer: a.

Task 31
Intermediate level (3 points)

The plague pathogen is characterized by:

Select all correct answers.

a) No core
b) Presence of glycogen in the cell wall
c) Spherical cell shape
d) Linear DNA
e) Rod-shaped cell

Answer: a, e.

Virology

Task 32
Entry level (1 point)

The Hepatitis A virus, which contains RNA, includes:

Choose one correct answer.

a) Chloroplasts
b) Capsid
c) Mitochondria
d) Ribosomes

e) Cell center

Answer: b.

Task 33
Entry level (1 point)

Biological model for the cultivation of the polio virus is:

Choose one correct answer.

a) Artificial nutrient medium
b) Enriched nutrient medium
c) Cell culture
d) Bacteriophages
e) Complex nutrient medium

Answer: c.

Task 34
Entry level (1 point)

The synthesis of bacteriophage proteins occurs at the stage of:

Choose one correct answer.

a) Adsorption on the cell surface
b) Cell penetration
c) Exit from the affected cell
d) Nucleic acid synthesis
e) Translation of bacteriophage components

Answer: e

Task 35
Entry level (3 point)

To create active immunity, it is necessary to use an immunobiological preparation in the form of:

Select all the correct answers.

a) Viral vaccine
b) Anatoxin
c) Erythrocyte diagnosticum
d) Allergen
e) Diagnostic bacteriophage

Answer: a, b

Biochemistry & molecular biology

Task 36

Entry level (1 point)

Which of the following can be found in the composition of a pyrimidine nucleotide in DNA? Choose one correct answer.

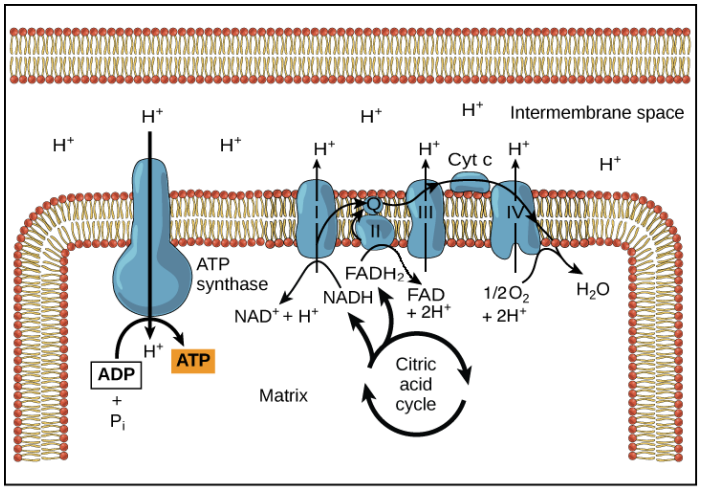
Choose one correct answer.

a) Nitrogenous base thymine
b) Monosaccharide ribose
c) Monosaccharide fructose
d) Nitrogenous base uracil
e) Monosaccharide glucose

Answer: a.

Task 37

Entry level (1 point)



Electrons and protons formed during respiration are transferred to the electron transport chain by:

Choose one correct answer.

a) NAD+
b) CO2
c) ATP
d) PVC (pyruvate)
e) Lactic acid

Answer: a.

Task 38
Entry level (1 point)

Which enzyme is required to synthesize DNA using the bacteriophage DNA strand as a template?
Choose one correct answer.

a) DNA polymerase
b) RNA polymerase
c) tRNA synthetase
d) ATP synthetase
e) Reverse transcriptase

Answer: a.

Task 39
Entry level (1 point)

During the dark phase of photosynthesis, which of the following processes occurs:

Choose one correct answer.

a) ATP formation
b) O_2 formation
c) Fixation of atmospheric carbon dioxide
d) Photolysis of waters
e) Krebs cycle

Answer: c.

Task 40
Entry level (1 point)

The synthesis of ATP during chemosynthesis occurs in the cells of:

Choose one correct answer.

a) Spirogyra
b) Hydrogen bacteria
c) Aspergillus
d) Euglena green

e) Parasitic bacteria

Answer: b.

Task 41
Entry level (1 point)

The cellular immune response is formed to this intracellular pathogen:

Choose one correct answer.

a) Measles virus
b) Tuberculosis bacillus
c) Diphtheria bacillus
d) Plague bacillus

Answer: a.

Task 42
Intermediate level (3 points)

Gonadal hormones are:

Select all the correct answers.

a) Somatotropin
b) Insulin
c) Estradiol
d) Thyroxine
e) Testosterone
f) Glucagon

Answer: c, e.

Task 43
Intermediate level (3 points)

Identify substances involved in the automatic regulation of breathing frequency:

Select all the correct answers.

a) Norepinephrine
b) Acetylcholine
c) Vitamins
d) Digestive enzymes

e) Bile
f) Mucin

Answer: a, b.

Task 44
Intermediate level (3 points)

Digestive enzymes that break down carbohydrates are:

Select all the correct answers.

a) Lipase
b) Maltase
c) Mucin
d) Amylase
e) Trypsin
f) Chymotrypsin

Answer: b, d.

Task 45
Advanced level (9 points)

During a routine examination of a 5-year-old child, leg curvature and abnormal chest development were observed. The parents reported that the child's sleep and wakefulness patterns are disrupted, with frequent waking and crying.

1. Which vitamin deficiency is likely responsible for these symptoms?
2. How will the level of this vitamin compare to the normal range in a biochemical analysis?
3. Is a fat-containing component necessary for the proper absorption of this vitamin? If so, why?
4. Besides recommending a vitamin course, what additional advice should be given to the parents to ensure proper care for their child?

Note: The assessment will consider the process and reasoning behind solving the task; merely providing the answer will not suffice.

Solution:

1. Answer: D – 5 points.
2. Answer: reduced/hypovitaminosis. – 1 point.
3. Answer: yes. – 1 point.
   D - fat soluble. – 1 point.
4. Answer: Encourage regular sun exposure, daily walks, holidays at the seaside, and preventive doses of vitamin D. – 1 point.